REPORT OF THE DIRECTOR OF THE PHILIPPINE WEATHER BUREAU.

Report of the Director of the Philippine Weather Bureau. 1902..

ATTENTION
SENIORS

COMMENCEMENT ANNOUNCEMENTS

— AND —

BOOKLETS

ON SALE

— AT —

ADMINISTRATION BUILDING

DEPARTMENT OF THE INTERIOR.

 PHILIPPINE WEATHER BUREAU.

REPORT

OF THE

DIRECTOR OF THE PHILIPPINE WEATHER BUREAU

1902.

PART II.

METEOROLOGICAL SERVICE OF THE PHILIPPINE ISLANDS.

REPORT OF ITS ESTABLISHMENT AND DEVELOPMENT UNDER THE SPANISH GOVERNMENT AND ITS REORGANIZATION UNDER THE GOVERNMENT OF THE UNITED STATES.

1865-1902.

BY FR. MARCIAL SOLÁ, S. J.,

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MANILA:
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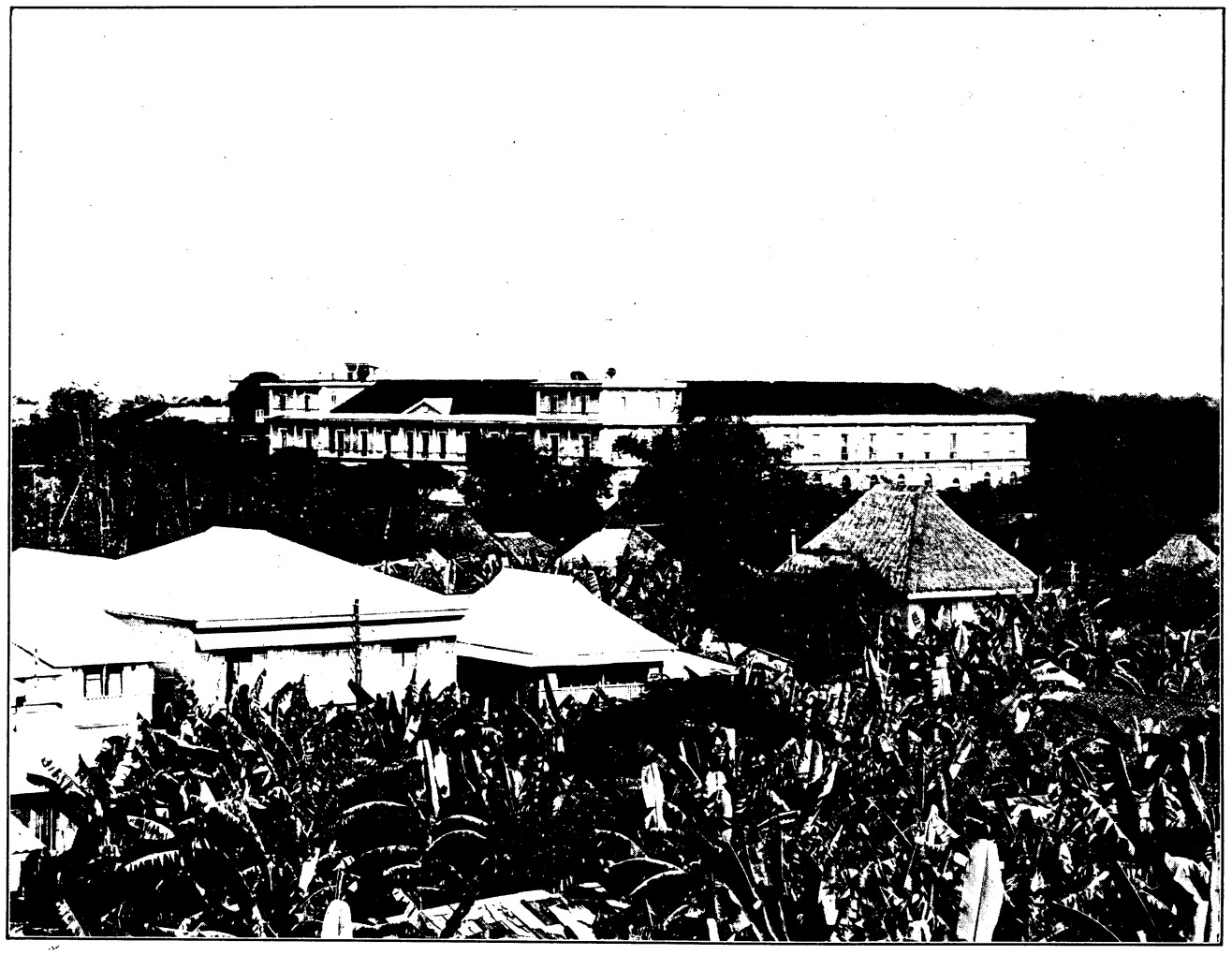

PLATE I.—GENERAL VIEW OF THE MANILA OBSERVATORY.

DEPARTMENT OF THE INTERIOR.

PHILIPPINE WEATHER BUREAU.

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INTRODUCTION.

The Meteorological Service of the Philippine Islands, the oldest in the extreme East, has been well known in these regions since the year 1880, when, thanks to the experience of the worthy Father Faura, its first Director, and to the advanced position which it occupied in the region of the typhoons of the extreme East, it began to send out to the Chinese coasts its typhoon warnings, observed several days in advance at the Observatory of Manila.

Up to the present, no formal report has been written on the Philippine Meteorological Service; a mere account of some of the apparatus was given in the series of monthly bulletins and there occurs a brief account of the same in the voluminous work "El Archipiélago Filipino," Tratado X, Climatología.[1]

But the reorganization of Philippine Meteorological Service, which has just taken place under the Government of the United States of America, and its notable improvement, especially regarding the secondary stations, offers a suitable occasion to make a more detailed report of the same. This may be looked upon as part of the first report, which appears in English, and belongs to the present year 1902. The principal object, then, of this report is to explain the condition of the Philippine Meteorological Service since its new official recognition by the Government of the United States. But in order to compare it with its former condition, and that we may see its gradual development, we shall begin by giving some idea of its first beginnings up to the time of its first official recognition in 1884. We shall then take a brief view of its relations with the other centers of the extreme East, and call attention to the more important events down to the present time; among others, to the celebrated attack directed against the Manila Observatory by the Director of the Observatory of Hongkong, Dr. W. Doberck.

Concerning the instruments in use in the Central Observatory and in the secondary stations, we shall simply enumerate them, as they are all sufficiently well known at the present time, merely inserting the description of a few, hitherto undescribed and recently invented at the Observatory.

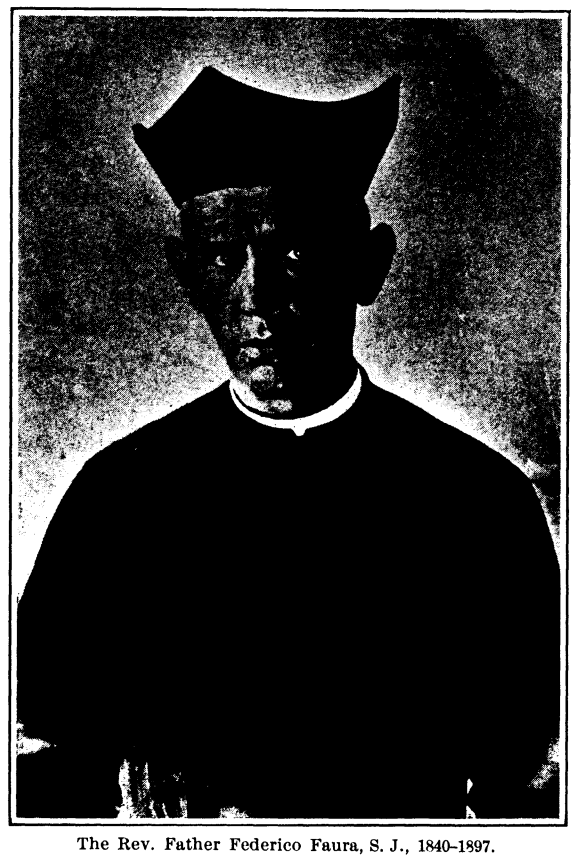
We believe that this report will not be uninteresting. Moreover, we look upon it as a grateful task to make known what assistance the Philippine Weather Service has received from the Governments of Spain and the United States to the great benefit of the navy, the merchant marine, and commercial interests in general.

September, 1902.

[1] "El Archipiélago Filipino," written by some of the Fathers of the Society of Jesus in the Philippines, comprises two volumes of text, large octavo, and an atlas of 31 maps. It was printed by the Government Printing Office, Washington, 1900. The two volumes of text were translated into English, and form Volumes III and IV of "The Report of the Philippine Commission, 1900." The atlas is comprised in the Special Publication No. 3, United States Coast and Geodetic Survey.

I. ORIGIN OF THE PHILIPPINE METEOROLOGICAL SERVICE.

Foundation of Manila Observatory.—The Manila Observatory began its work in the year 1865 at the college known as the Ateneo, under the direction of the Fathers of the Society of Jesus. This date may be given as the beginning of the Philippine Meteorological Service, not only because before that time there was no other institution in the Philippines engaged in the study of meteorology, but especially because for a long time previous the professors of that college had dedicated themselves to the study of predicting the existence and course of the cyclonic storms which are so frequent in this part of the globe. This may be seen from the occasion which led them to take up this scientific work, which was the destructive typhoon which occurred in September of that year, a year of sad recollections for the whole of Luzon.



The Rev. Father Federico Faura, S. J., 1840–1897.

In the beginning a few of the most indispensable instruments were installed, for the observation of the principal meteorological elements. Nevertheless from this same year the Fathers began to publish a monthly leaflet and an annual one, illustrated with various curves, giving to the public the results obtained from their observations of each month, with a brief résumé of the principal atmospheric perturbations which occurred during the year.

The enthusiastic Director of the new scientific center, Fr. Federico Faura, was not slow to increase the small number of instruments which served as the foundation for his investigations. In 1868 the Universal Meteorograph of Fr. A. Secchi, which only a year before had received such enco-

miums at the Exposition of Paris, was put up. Moreover, owing to donations made by certain private individuals, who were anxious to see the Observatory improved, a complete collection of apparatus for direct observation was acquired, all of which instruments were compared and corrected from the standard instruments of the celebrated Observatory of Montsouris. Hence, as the data gathered day by day became more complete, the Observatory, in the year 1870, began to publish in place of the leaflet mentioned above, a monthly Bulletin. This publication contained, besides scientific discussions, the results of the daily observations of all the meteorological elements, taken at three-hour intervals, namely, 6 a. m., 9 a. m., 12 noon, 3 p. m., 6 p. m., 9 p. m., together with the corresponding mean values.

This work, nevertheless, for some time had little practical value beyond the fact that it made known to different national and foreign centers, through the exchange of publications, the existence of this branch of science here.

First storm predictions.—Almost fourteen years of observations passed before the founders of the Observatory obtained the object which they had proposed to themselves. But the public of Manila considered the time well spent when, in 1879, Fr. Faura began to give out his warnings, and to him belongs the honor of being the first scientist in the Far East to predict the existence, progressive movement, and to determine the probable trajectory of the cyclones, known in the China Sea as typhoons and by the natives of the Philippines as baguios. Finally, after a long and close study of the laws which govern the movement of the barometer in these latitudes, the aspect and movements of the cloud forms, the veering of the winds and cloud currents on the approach of one of those formidable atmospheric disturbances, and the various paths which they usually follow during the different periods of the year, Fr. Faura believed that the day had come when he was able to announce, in advance, the approach of the typhoons, and offer invaluable services to the inhabitants of the Islands, especially to the maritime and commercial companies. He made his first typhoon prediction on July 7, 1879, indicating that the vortex was crossing over the provinces of Northern Luzon; the sad news of destruction wrought in the path of the storm in the Provinces of Isabela and Cagayan confirmed the truth of his announcement.

He predicted another typhoon on November 18, and this time as dangerous for Manila. The commotion produced in the minds of the inhabitants by this announcement was indescribable. The Captain of the Port, D. Alejandro de Churruca, who had followed with great interest the weather notices since July 7, sent word to all points of the bay that not a single ship should leave its moorings. The Governor-General, Domingo Morriones, wished to find out directly if the rumors of the news from the Observatory were correct, and he sent a message to Fr. Faura, begging him to give him an account of what he had observed. To this Fr. Faura replied by confirming the warning already given, and adding that he believed it convenient that precautions be taken; as a matter of fact, this was done, notwithstanding the fact that some said that no reliability was to be given to the warning. Thanks to this action, the mishaps which occurred were comparatively insignificant. The storm broke with fury over the capital at noon on the 20th; in those ports without telegraphic connection with Manila, and where consequently warning could not be sent, the destructive effects of the hurricane were very notable, forty-two boats being lost in the south of the island, and many persons losing their lives.[1]

The predictions of this baguio, as was to be supposed, attracted considerable attention to the Observatory of the Ateneo, and from that time on the warnings from it were looked upon with consideration. We shall not delay in describing in detail the successive storms which were predicted, for this would be a long task; it will suffice to indicate, in order that we may see what good foundations Fr. Faura had for coming forth with his predictions, that from the year 1879 to the year 1882 he announced 53 typhoons, and in all that time he never made a mistake in announcing the existence and

[1] A description of this hurricane, written by Fr. Faura, may be seen in the review of that month, contained in the annual volume for 1879, "Observatorio Meteorológico de Manila, bajo la dirección de los PP. de la Compañía de Jesus. Observaciones verificadas durante el año 1879." A map accompanies the report on which is traced, among others, the path of this cyclone, and the position of the isobars in its progress across the Archipelago.

position of the storm; in three cases he was slightly mistaken in the direction given, and in two cases the storm spent its force before arriving at the points which seemed threatened.

We should note that such splendid results were due, in part, as well to the assistance given through their observations by various marine officials, as to the telegraph, the first line of which was opened between Manila and Cavite on December 1, 1872. It was a very opportune idea that meteorological observations should be taken in the telegraph stations by the operators at these points in order to communicate them as soon as possible to the Director of the Observatory, as was proposed by D. José Batlle, inspector-general of telegraphs, to the director of the civil administration, who by an act dated December 7, 1878, confirmed the project in these terms: "According to the proposal made by the Inspección General de Telégrafos, I hereby authorize the project in order to put at the disposal of the Meteorological Observatory of this capital all the weather observations which may be made at the telegraph stations of these Islands, and moreover that electrical connection be established between the central station of telegraphs and said Observatory, to the end that their work may be made more accurate and more useful, utilizing for this purpose the material and personnel which this work may require, under the ordinary appropriation for the expenses of the line and stations, without further expense to the State."

The first typhoon warnings sent to Hongkong.—The benefits of the typhoon warnings were not limited to the Philippine Archipelago alone. In 1880, after Manila had been connected with Hongkong by cable, various warnings were sent to that colony, where they received considerable comment in the local press, particularly in the Hongkong Daily Press. The reason which induced the Philippine Meteorological Service to extend its warnings as far as the China coasts was the following request: Mr. J. Hennesy, governor and commander-in-chief of Hongkong, sent an official communication to D. Fernando Primo de Rivera, Governor and Captain-General of these Islands, begging him to use his influence with the Director of the Observatory of Manila to the end that a daily and methodical exchange of meteorological notes be made with the port of Hongkong, and even between the ports of China and those of the Archipelago, in such manner as may seem best to the above-mentioned Director. This communication was dated May 25, 1880.

The directors of the Observatory of the Ateneo replied to the communication received, stating that the project of the governor of Hongkong had always been one of the most cherished ideas of the Observatory; especially, since the data gathered from diverse points in the Archipelago had made it evident that the gyratory storms which form in the Pacific reach the China coasts two days and more after they have ceased to be felt on our coasts; therefore, even with the poor means at their disposal, the exchange of notices proposed could not but be highly satisfactory, so soon as the cable company would offer to transmit the warnings free of charge.

The typhoon warnings from Manila were highly appreciated in the neighboring colony and on the coasts of China.[1]

From the many favorable notices which appeared every year in the Daily Press of Hongkong, we shall quote, as an example, only one, from the issue of August 18, 1883: "So the typhoon telegraphed from Manila a fortnight ago as then raging on the coast of Luzon, but traveling a direction uncertain, and of which we happily got nothing worse than the several inches of downfall per diem, has now been heard of as having entered the China Sea considerably to the north of Hongkong, giving some of the coast steamers no end of a dusting, and paid Ningpo and Shanghai a visit with its outer edge. Thus, in each and every instance this year the typhoon announced from Manila has been closely followable, and further practical proof has been given, if such were needed, of the immense value of such telegraphic information."

The practical results achieved by the Meteorological Service of the Philippines in its relations with the Asiatic continent were so evident that many persons noticed the want at Hongkong not only of a similar service but even of a complete observatory. A meeting was held to discuss such a meas-

[1] Eloquent testimony of the regard in which these warnings were held may be seen in an article, sent by Capt. Robert Talbot, of the steamer *Esmeralda*, to the editor of the Hongkong Daily Press, in the issue of September 8, 1880. See also the correction, also by Captain Talbot, which appeared in the same paper on the 15th of the same month.

ure, and the members consulted with the Director of the Manila Observatory with a view to obtain his opinion with regard to the utility which might result to navigation from the establishment of another observatory in Hongkong. Fr. Faura replied favorably, explaining the advantages to be expected from such a foundation, not only to the colony itself and to the China coasts but also to all who have to sail those seas.[1] Before coming to a final decision, they discussed various other means of communication, which we pass over as not touching our present purpose.

II. PROJECT FOR THE ESTABLISHMENT OF AN OFFICIAL SERVICE OF SECONDARY STATIONS THROUGHOUT THE ARCHIPELAGO.

Preliminary notes.—Meteorology is truly scientific, at least from the seventeenth century, when Torricella enriched it with the barometer, an instrument which up to the present day is the most valuable instrument at our disposal for obtaining a knowledge of the weather. But rapid progress in this science began only after the invention of the telegraph, when, by means of this invention, it became possible to compare at any desired instant the condition of the weather in districts far removed from each other, thus facilitating the knowledge of normal and periodic atmospheric phenomena, and the abnormal features which they often exhibited; and, above all, it afforded a means of announcing their approach while still at great distances.

From this time on, the organization of meteorological services, more or less perfect, spread rapidly over all parts of Europe and America which were in communication with each other and with a central office by means of telegraphic lines. And as it was altogether indispensable, for the accomplishment of the necessary union among so many principal and secondary centers, that some uniform method be followed in taking simultaneous observations in the different parts of the globe, with a view to making forecasts of the weather, many scientific congresses were held in order to come to some common understanding. One congress followed another, from that of Brussels in 1853, to the last one held in 1900 during the Exposition at Paris.

With his usual foresight Fr. Faura kept abreast of the advancement being made in meteorological science, and of the methods employed in other parts of the world. Hence, we find him in the year 1877 at the Colegio Romano at the side of Fr. Secchi, S. J. After making a round of other scientific centers, he visited the Paris Exposition of 1878, and at Stonyhurst compared notes with the celebrated Fr. Perry, S. J.

Assistance given to Observatory by many individuals.—On his return to Manila, Fr. Faura was very anxious to extend, as far as possible, the Meteorological Service throughout the Archipelago, and did all in his power to accomplish this object.

The Observatory of the Ateneo still retained its character of a private institution, but it enjoyed the cordial support and encouragement of all lovers of progress. An evidence of this is shown by the subscription started by the Manila daily El Comercio for the purpose of making a gift to the Observatory. In its issue for June 2, 1881, the above periodical speaks thus: "I am not for leaving everything to the State and the municipality, or, in one word, to the official body," remonstrated a friend of ours this morning, who like ourselves, appreciates the Meteorological Observatory, and who professes sincere admiration for the illustrious priest who directs it; "both home and foreign merchants, ship owners, the whole people, each in its own particular sphere should assist by subscriptions for instruments for this establishment, and I believe that if the papers start a subscription for this purpose, there would not be a merchant or ship owner but would, with some of his capital and according to his means, help in supplying what is wanted. We are very much in favor of the idea and for some time past we have opened a subscription list in our columns, and have received of late the following amounts." The list of subscriptions follows and continued for several days until a sufficient amount was obtained to purchase new apparatus, such as the Beckley anemograph and the Standard barometer of Negretti.

[1] Mr. H. S. Palmer, major of Royal Engineers, of Hongkong, in a well-written memoir to the British Government in April, 1881, speaks as follows concerning the projected observatory for the colony: "No one perhaps has welcomed the project more cordially than the Rev. Fr. Faura, the earnest Director of the Meteorological Observatory at Manila."

What had been done in Manila became known at Hongkong, and some ship owners together with the insurance houses of that colony, in view of the benefits which their ships and interests derived from the warnings which it sent forth, desired to make another donation to the Observatory.

Attitude and action of the Manila authorities.—As may be easily gathered from the above lines, Fr. Faura had the confidence of public opinion and had no difficulty in realizing his plans. Among those who gave him much encouragement we must mention the then Captain of the Port, D. Alejandro de Churruca, and the Captain of the Navy, D. Felipe Canga Arguelles, who, persuaded that the private Observatory of the Ateneo ought to be made official and the center of a network of secondary stations, offered the suggestion first to the General of Marine and afterwards to the Governor-General, who ordered that a commission be formed of competent persons to discuss the project, naming as president the General of Marine, who at that time was D. Rafael Rodriguez de Arias. After various sessions it was resolved to organize a Meteorological Service over the whole Archipelago in such a manner that all the secondary stations to be established by the said commission at the different points, should be dependent in all their functions on the central station, which latter should be properly developed, and to which daily observations should be sent by telegraph, as well as written reports at the end of the month for discussion and publication. The final result was that toward the end of October of the same year, 1880, a memorial was presented to His Majesty's Government, for approval of the project. It will not be uninteresting to quote a few words from the memorial referred to, a copy of which we have at hand, where the reasons for the project are stated. "In bringing before the consideration of His Majesty's Government the project of the Meteorological Service of this Archipelago, we do not propose to eulogize the importance of such a service in general; for the grand and beneficial results, which for some years past have followed the telegraphic dispatches emanating from Washington, giving the note of warning to the various nations of Europe, that they may take measures against the formidable hurricanes which cross the Atlantic, are well known to all persons of consequence. We wish only to call attention to the motives which induce us to explain how useful such a service would be if established in the Philippines.

"As the Philippine Archipelago is situated within the zone of formation of the cyclonic storms, scarcely a year passes in which we have not to lament disasters in some of the provinces, and in which the catalogue of shipwrecks is not increased. If, then, we were to establish the meteorological stations referred to, one can easily see that when such storms approach the Archipelago notices could be sent in due time to the western coasts and to the central provinces of Luzon, since the storms are felt much sooner at the more eastern points; and by means of the observations received from such points, absolute certainty of the storm may be acquired, which otherwise might be only suspected.

"Moreover, united by cable with the neighboring colony of Hongkong, the Philippines, from a meteorological standpoint, will be in an exceptionally advantageous position for predicting the weather for all the Chinese and Japanese coasts, and consequently, will be able to be of the greatest assistance to the ships that sail those seas. Hence, the various dispatches sent out concerning the cyclones will be of much greater utility, and will be of greater importance to the Archipelago when the secondary stations in project shall have been established."

On these and similar reasons were based the decisions of the commission above referred to, when it decided to present its memorial to the Government at Madrid for approval.

It is scarcely necessary to mention here each one of the points discussed by the members of the commission; nevertheless we shall note in passing that as the greatest difficulty found in the way of the speedy establishment of the projected service was the want of a suitable situation for the Central Observatory, the Jesuit Fathers, who were represented in the commission by Fr. Faura, offered to erect a building at their own expense, distinct from the one used up to the present for their observations, where an observatory of the first class could be installed, and to undertake also to supply it with the best apparatus, and raise the institution up to the standard which all desired.

III. OFFICIAL ERECTION AND FURTHER DEVELOPMENT OF THE METEOROLOGICAL SERVICE OF THE PHILIPPINES.

Approbation by Royal Decree.—When the above-mentioned memorial was received and examined at Madrid, His Majesty's Government did not fail to recognize the importance and utility of the proposal, since it well understood that such an undertaking was in perfect accord with the prestige and interests of Madrid in its Philippine possessions. It sought, nevertheless, information from the Council of Civil Administration in the Islands and from the Observatory at San Fernando.

With regard to the former, we shall quote here, for brevity's sake, merely the reply given by the Governor-General. It is as follows:

MANILA, *June 14, 1881.*

YOUR EXCELLENCY: I have the honor to present, through the hands of Your Excellency, a copy of the proposed measure for the establishment and organization of a Meteorological Service in these Islands.

The importance of the subject, the want to be satisfied, and the relatively small expenditure required for this improvement, seeing that we make use of the means already at our disposal, render unnecessary on my part any recommendation, and I simply limit myself to begging Your Excellency to be pleased to petition His Majesty for proper approbation.

May God protect you, etc.

FERNANDO P. DE RIVERA.

Your Excellency MINISTER OF ULTRAMAR.

The Observatory of San Fernando also reported favorably, whereat His Majesty, in view of the favorable opinions of the authorities and the views of competent persons, signed the following

ROYAL DECREE.

In accordance with the proposal of the Minister of Ultramar, with that of the Minister of Marine and with the recommendation of the Council of the Philippines and of the Director of the Observatory of S. Fernando, I hereby decree as follows:

ARTICLE 1. Let a Meteorological Service be established in the Island of Luzon depending on the Observatory which the Society of Jesus has established in Manila. This Observatory, with the character of central, shall be known as Observatorio Meteorologico de Manila, it shall be under the dependency of the General Board of Civil Administration of the Philippine Islands, in charge of the said Society, and shall take all kinds of observations, and especially those which refer to the change and prediction of the weather, dedicating itself to the study, compilation, and publication of those which may be transmitted to it from the secondary stations.

ART. 2. For the immediate carrying out of the service under consideration and to promote as far as possible its future development, meteorological stations shall be established at the following telegraphic points: South of Manila, six stations, situated at Albay, Daet, Atimonan, Tayabas, Punta Santiago, and Punta Restinga; three on the western coast, situated at Cabo Bolinao, Vigan, and Laoag, and four on the central line north of Manila, situated at Aparri, Tuguegarao, San Isidro, and Cruz de Caraballo.

ART. 3. These thirteen stations shall depend on the central and send their reports conformably with the special ordinance which shall be drawn up by the General Board together with the Director of the Meteorological Observatory of Manila, and after consultation with the authorized chief of the telegraph line of the Islands. The ordinance drawn up in this manner shall take effect, with the approbation of the Governor-General of the same Islands, subject, however, to examination and decisions of the Minister of Ultramar.

ART. 4. The central meteorological station, which must be put in telegraphic communication with the central station of communications, in order that it may receive the dispatches from the secondary stations without delay, shall be in charge of a Director, assisted by a subdirector, both to be proposed by the Superior of the Mission of the Jesuit Fathers in the Philippines, for appointment by the Government. The subordinate observers, calculators, mechanics, draftsmen, apprentices, and messengers shall be under orders from the said Director, who shall propose them and whom the General Board of Civil Administration of the Islands shall appoint, with the amount which may be assigned for the maintaining of subordinates. The staff destined for the secondary stations, trained also under the Director of the Central Observatory, shall be appointed by the said Board of Civil Administration, with the approbation of the authorized chief of the department of telegraphs, as such appointments may possibly affect the peculiar service of the system.

ART. 5. By way of reimbursements for the services which the Reverend Fathers of the Society of Jesus are to offer to the State in the discharge of the offices of Director and subdirector of the central meteorological station, 1,500 pesos a year shall be assigned to the former and 1,000 to the latter; the sum of 2,052 pesos a year being provided for the support of the subordinate staff of the said central station, and that of 1,872 pesos for that of the staff which is to operate the meteorological service of the thirteen secondary stations. In like manner 1,500 pesos are assigned for the printing of the observations; for expenses for stationery and correspondence of the Central Observatory, 1,000 pesos; for maintenance and care of the building occupied by said Observatory, and

for material for all the stations, 1,500 pesos; and for expenses for stationery for the thirteen secondary stations, 432 pesos.

ART. 6. The 6,424 pesos, the sum of the amounts assigned for the staff of all the stations, as well as the 4,432 pesos assigned for the other expenses, shall be included in the appropriations for the coming economic year 1884–85 and in future appropriations one-third of the above-mentioned sums is to come from the State appropriation and the remaining two-thirds from the local funds.

ART. 7. In proportion as the telegraphic system of the Archipelago develops, placing other islands of the same in communication with Luzon, the Governor-General, with the advice of the Director of the Central Observatory and the General Board of Civil Administration, shall propose to the Government the establishment of new meteorological stations, in addition to those which are now created.

ART. 8. In case this extension of the meteorological system can not be realized, the Minister of Marine, taking advantage of the naval stations which exist or which may be created in the Archipelago, shall adopt suitable measures in such way that the chiefs of the same shall organize, each one in the station under his command and under the terms which his zeal may suggest in view of so important a service, observations as exact as may be possible of the meteorological phenomena, which in their respective territory they may be able to gather, and remit the results of their work at convenient times to the Director of the central meteorological station at Manila, coöperating in this way to the perfection of a study, in which science and humanity are vitally interested.

Given at the Palace on April 28, 1884.

ALFONSO.
MANUEL AGUIRRE DE TEJADA,
Minister of Ultramar.

On May 29 of the same year another royal order was issued, ordering that proper dispositions be made that the marine coöperate with the work of the Observatory, especially at those points not reached by the telegraph lines.

Actual establishment of the secondary stations and their organization.—In virtue of the above royal orders, the Observatory of Manila and the service, which for so many years it had been carrying on for the public good, came forth from its narrow quarters, from its private sphere, and we may say that a new era began for both.

Encouraged by such a result, the worthy Fr. Faura set to work to carry out with his usual enthusiasm, and to put into practice as perfectly as possible, the whole scheme of the royal decree, the contents of which may be reduced to two principal heads, namely, the perfecting of the Observatory and the establishing of the secondary stations. Passing by for the moment the manner in which he perfected the Central Observatory up to the point of rendering it possible to take there all kinds of observations, we shall briefly review the process of the organization of the secondary stations of the Archipelago.

Nearly all these were established within the years 1885 and 1887. The first to operate and the most important, on account of their geographical position for the prediction of typhoons, were those in southeast Luzon. Fr. Faura himself, accompanied by Fr. Batlló and D. Toribio Jovellanos, first-class observer, set out from Manila to erect them on April 7, 1885. They visited successively the towns of Albay, Daet, Atimonan, and Tayabas, returning to Manila on May 10. With the same object in view the above-mentioned observer was sent to the other points of central and north Luzon. The dates on which these stations began to operate may be seen below:

Stations.	Latitude north.		Longitude east of Greenwich.		Date.
	°	′	°	′	
C. Bolinao	16	24	119	46	Aug. 13, 1884
Pta. Santiago	13	46	120	39	Aug. 19, 1884
Pta. Restinga	14	16	120	37	Aug. 20, 1884
Daet	14	05	122	57	Apr. 12, 1885
Albay	13	09	123	42	Apr. 24, 1885
Tayabas	14	01	121	34	May 1, 1885
Atimonan	13	59	121	53	May 5, 1885
Aparri	18	21	121	35	June 5, 1885
Vigan	17	33	120	24	Aug. 20, 1885
Tuguegarao	17	37	121	41	Sept. 10, 1885
Bayombong	16	28	121	12	Oct. 10, 1885
Laoag	18	12	120	37	Dec. 1, 1885
S. Isidro	15	18	120	52	July 1, 1887

Almost all the instruments for direct observation provided for the stations were from the well-known firm of Negretti & Zambra; they were as follows:

Fortin's barometer.	Anemoscope.
Maximum thermometer.	Anemometer.
Minimum thermometer.	Vaporimeter.
Psychrometer.	Pluviometer.

Some stations, moreover, were supplied with three of Richard's self-registering instruments, the barograph, psychograph, and thermograph.

To assist in preserving and managing with exactitude the above instruments, the observers, in addition to a minute description of each one, had in their possession a small pamphlet[1] containing definite instructions dictated by the Director, and which accompanied the regulations which were to be followed by all. A valuable pamphlet of Fr. Faura's, the fruit of his many years' experience, entitled "Senales Precursores de Temporal en el Archipiélago Filipino," published in 1881, served with other publications as a guide for knowing the state of the weather.

With regard to observations, they were to be sent daily by telegraph to Manila and to be taken at 10 a. m., 12 noon, and 4 p. m., and when the weather was suspicious, or when asked for by the Observatory, even more frequently. The telegram was to include the reading of the barometer, the thermometer wet and dry, the direction and force of wind, the quantity, direction, and velocity of the clouds, the rainfall since last observation; all this was included in the following abbreviated form:

B. 759.48, S. 28.4, M. 26.2, V. NE., F. 4, N. 8, D. NE., V. mucha, Ll. 8.2.

Moreover, all the secondary stations sent to the central, before the 10th of each month, three tables containing by decades the observations made daily during the preceding month at the hours of 6 a. m., 10 a. m., 12 noon, and at 4 p. m., 6 p. m., and 8 p. m. These daily observations from each one of the stations began to be published in 1885 in the Boletin Mensual del Observatorio. If a storm was imminent, the observer was instructed to take observations on all his instruments every hour, if possible, making his notes on special registers, according to the form indicated in the models.

So far we have considered the stations merely from a meteorological standpoint, but we must now add that all of them took records of earthquakes and other seismic phenomena felt in the locality. Nevertheless, only fourteen of them in the Island of Luzon, called meteorological-seismic stations, sent telegraphic notice of earthquakes as soon as they occurred.

After meteorological work, the study of seismic phenomena is the oldest of the branches taken up at the Observatory. In 1880 various seismographs were in operation at the Ateneo during the unfortunate and memorable earthquake of that year. By the aid of these instruments Fr. Faura, with a view to satisfy the unusual anxiety which the whole people felt to know something about what was occurring, was able to communicate daily to the public immediately after the occurrences, various notes concerning each one of these formidable phenomena; he finally published an interesting study of the matter, together with the curves traced on the apparatus.[2] The authorities and the general public were so pleased with these labors that in view of the same the Ayuntamiento, or city council, in public session held on July 26, resolved to confer on Fr. Faura the title of "Adopted Son of Manila."

There were three stations in operation in the other Spanish possessions of the Pacific, namely, at Yap, Western Carolines, at Ponapé, Eastern Carolines, and at Agaña, Marianas Islands, all of which were regulated in the same way as the preceding ones.

Besides these seismical meteorological stations there were many others, which were not official ones, and which were not united by telegraph with Manila. These were distributed principally in the Visayas and Mindanao, and even in the Carolines and Marianas, and through their daily observations, remitted monthly to this Observatory, were of great service in the study of the hurricanes or Philippine cyclones.

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[1] "Instrucción práctica para el uso de los instrumentos meteorológicos de las Estaciones Secundarias de las Islas Filipinas."

[2] "Observaciones Seismometricas de los terremotos de Julio de 1880."

The names of these stations, which we may call third-class stations, and their geographic positions are as follows:

Stations.	Latitude north.		Longitude east from Greenwich.	
	°	′	°	′
Joló	6	03	120	59
Mati	6	56	126	14
Ponapé (Oriental Carolines)	6	46	158	23
Zamboanga	6	54	122	03
Dávao	7	05	125	35
Cotabato	7	16	124	12
Polloc	7	21	124	12
Dapitan	8	40	123	23
Tándag	9	02	126	10
Yap (Oriental Carolines)	9	29	138	05
Surigao	9	47	125	29
La Carlota (model farm)	10	24	123	05
Cuyo	10	51	121	00
Calbáyog	12	06	124	38
Mambúrao	13	16	120	32
San Luis de Apra (Guam)	13	28	144	44
Agaña (Guam)	13	30	144	45
Magálang (agronomic station)	15	14	120	48
Isabela (agronomic station)	17	10	121	41

Relations between the Observatory of Manila and that of Hongkong.—Having seen in the preceding paragraphs the beginning of the Philippine Meteorological Service, and how it acquired its stability and development by official recognition, the reader will naturally like to know when the other services in the extreme East began operations, and how ours established direct relations with them.

Hence we shall say a few words now concerning each one of them, commencing with that of Hongkong.

It has been already stated that the immediate occasion of its foundation were the good results accomplished by Manila Observatory through its warnings. During the months of September and October, 1883, the future director of the Observatory of Hongkong, Mr. W. Doberck, made a tour of inspection through some of the ports and light-house stations along the coasts of China and the neighboring islands, in which points meteorological stations had been in operation for some years. Concerning them he says, under No. 4 of his memorial addressed to the Colonial Secretary,[1] and dated November 8, 1883: "I have the honor to report that at present no meteorological service appears to exist in China. Some instruments are read in the treaty ports and light-houses, but no particular system is followed. The instruments are generally useless. They are not of approved construction or properly placed, and corrections are not determined or applied, nor are the observers properly instructed."

And further on, after naming thirty-five meteorological stations which it would be convenient to erect, he demands that the observations from such points should pass through his hands, so that he may discover and correct the errors made by the observers. On reading the whole memorial one can hardly resist the impression that Mr. Doberck attributes too much importance to himself in meteorological matters. Later on, he published some meteorological instructions which were to be followed by all the observers of the China coasts, and it caused the Rev. P. M. Dechevrens, S. J., director of the Observatory of Zi-ka-wei, no little amusement, when Mr. W. Doberck wished to make him conform to them, just as though that center depended by some natural right on the said gentleman.

On November 12, 1883, Mr. Doberck was officially appointed director of Hongkong Observatory, and on January 10, 1884, that establishment began its work, publishing the same month its first monthly bulletin.

Concerning Mr. Doberck's publications, we can not but call attention to the fact that neither

[1] Included in Government notification No. 380, dated November 17, and can be seen in the Reports of the Observatory of Hongkong for 1883.

in the above-cited memorial nor in his weather reports does he mention a single word[1] of the meteorological services of the observatories of Manila or of Zi-ka-wei, both of them anterior in point of time, and with both of which the Observatory of Hongkong had had much communication, as is evidenced in the memorial presented for approbation to the British Government, by Maj. H. J. Palmer of the Engineer Corps, under date of July 17, 1881.

Such a proceeding may perhaps serve as a kind of forerunner for the animosity, which Mr. Doberck clearly showed on various occasions later on, against the directors of those centers.

We can not pass by a fact which directly appertains to the subject of our work. Daily observations and storm warnings were, as has been said, exchanged from the very beginning between the observatories of Manila and Hongkong. But, for some inexplicable reason, Mr. Doberck on repeated occasions kept back our telegrams without using them, or giving them out to the public, even at times to the detriment of navigation. This gave rise to complaints on many sides from those interested, with the result that in future the warnings were sent simultaneously to Mr. Doberck and to the Spanish consul, the latter official sending them immediately to the local press for publication. Nevertheless, Mr. Doberck's letters to Fr. Faura were written in friendly terms up to 1887, at which time he spoke openly against the Manila Observatory on the occasion of the warnings sent out by it concerning the typhoon of September 19 and 11 of the same year. From that time on, relations were less friendly, until the year 1898, when they were completely broken.

Opportunity of sending the warnings directly to Saigon and Macao.—The interest which Mr. Doberck failed to show in the telegrams from Manila, others did show. In an official communication of the 7th of May, 1885, the captain of the port of Macao complained to Fr. Faura that, owing to the ill will of Mr. Doberck, so rumor had it, the warnings from the Manila Observatory sent to Hongkong were not communicated to him. He then adds: "Imagining that the same thing will happen this year, and realizing the great benefits to navigation which result from the reception of such telegrams, I have asked and obtained authorization from the government of this colony to direct myself officially to your reverence, as I actually do, asking you to kindly send me directly all the said telegrams, this government undertaking to stand whatever expenses are incurred in the transmission of them. I put myself at your reverence's disposal to transmit them to whatever other points your reverence may deem convenient, to the end that the results of the arduous labors of your reverence may not be shut up within the archives of the observatory of the neighboring colony of Hongkong, to the great detriment of the general public."

If we pass from Macao to Saigon, we shall notice in the authorities of that French colony the same appreciation of the afore-mentioned warnings. In accordance with our purpose of giving an idea of how the meteorological net went on extending itself throughout the extreme East, we shall quote what the French consul in Manila, under date of December 30, 1887, communicated to the Observatory, namely, that, beginning from January, 1888, they would send by telegraph the observations of Saigon, asking ours in return. In this way our telegraphic service broadened out as far as Saigon and other stations of Indo-China.

The Observatory of Zi-ka-wei.—Previous in point of time to the stations of the China coast, above mentioned, there already existed the Observatory of Zi-ka-wei near Shanghai, under the charge of the Jesuit Fathers, who had founded it in 1872. From this date they had been publishing their ordinary observations, and a great number of memoirs, mostly on meteorological subjects, since the principal object of the directors from the beginning was to assist by their typhoon warnings the marine of those seas where the Observatory is held in high esteem. Recognizing the good results which might follow from such action, Fr. Marc Dechevrens, S. J., published on January 13, 1882, a notable memorandum on the meteorological service which it would be convenient to establish on the China coast.[2]

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[1] The following is his reference to the observations at Manila: "In the China Coast Meteorological Register, based on information transmitted by the Great Northern and Eastern Extension Telegraph Companies, which I have published daily, a summary is given of the atmospheric conditions in Manila and along the coast of China," etc.

[2] This was reproduced by the Hongkong Daily Press on January 31, 1882, accompanied by very favorable comments on the observatory of Zi-ka-wei, and on the then director, Fr. Dechevrens, S. J.

At present there is a Meteorological Society at Shanghai, whose president is the director of the Observatory of Zi-ka-wei. To this center meteorological telegrams are sent daily from 17 stations of China, 7 of Siberia, 2 of Corea, 7 of Japan, 5 of Formosa, 1 of the Philippines, and 1 of Cochin China.[1] There are some 52 stations which send a bulletin of daily observations at the end of each month, and there are 17 that receive warnings from the Observatory of Zi-ka-wei, the greater number of which are provided with signals for the information of the public, according to a plan proposed by the said observatory, and adopted generally all along the China coast, except at Hongkong.[2]

Meteorological service of Japan.—Another of the well-known services in the extreme East is that of Japan. It began with the Central Meteorological Observatory of Tokio, inaugurated June 5, 1875, from which the secondary stations are directed in accordance with the imperial decree of August 3, 1887. These latter stations, to the number of 80, are divided into two categories, namely, first class and second class. The fourteen first class ones take hourly observations, the others every four hours. The instruments with which they are supplied and their whole organization may be seen described with interesting details in two pamphlets which have been published.[3]

The exchange of observations between our Observatory and that of Tokio dates from 1890, when his excellency the minister of foreign affairs of Japan, effected the exchange through the Governor-General of the Philippines. In July, 1892, telegrams began to come from Nagasaki, together with those from Shanghai, Amoy, and Haiphong. This was the result of the negotiations conducted by Fr. Miguel Saderra Mata, the Director of the Observatory at the time, during the expedition which he made to the coasts of China and Japan for the sake of taking magnetical observations. The great strides taken in a short time by the Japanese meteorological service induced the various observatories of the extreme East not to be content with merely the observations of Tokio and Nagasaki, but led them to profit also by those of other stations of the Empire.

Little by little and almost insensibly the number of services from Japan went on increasing, until in 1898 they numbered seven. These seven stations, whose observations continue at the present day to be received at the Observatory, are the following: Tokio, Nagasaki, Koche, Kagoshima, Naha, Oshima, and Ishigakijima. The last three belong to the Liukiu group of islands, and are those that are of greatest service in giving typhoon warnings.

Before the Chinese-Japanese war observations were received daily at this Observatory from Amping and South Cape, stations on the Island of Formosa. In 1898 Fr. Algue, considering how important and useful observations from said island would be to this Observatory, and bearing in mind the fact that the Japanese Government had already five meteorological stations established there, directed a communication to General Otis, Military Governor of the Philippines, under date of September 14, begging him to do his utmost to obtain from the Japanese Government the transmittal to this Observatory, twice a day, of the observations from the following five stations, situated on the coast and channel of Formosa: Taihoku, Taichu, Tainan, Koshun, and Hokoto. On October 31, 1899, the desired observations began to be received, being probably the result of the negotiations of the United States consul at Hongkong, in accordance with instructions received from the said General Otis.

We feel compelled, in justice and gratitude, to mention here that the meteorologcial telegrams received and transmitted daily by the Observatory are sent gratis, thanks to the truly humanitarian assistance of the Eastern Extension Australasia and China Telegraph Company.

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[1] See "Shanghai Meteorological Society," Fifth and Sixth Annual Reports, 1896 and 1897, by Rev. Aloys. Froc, S. J., director of Zi-ka-wei Observatory.

[2] See the "S. M. S. Report for 1899," page 7. It is to be regretted that at Hongkong the typhoon warnings emanating from the Observatory of Zi-ka-wei are refused. In the typhoon of August 1–6, 1901, the captains would have been warned at least twenty-four hours earlier than they actually were, and thus spared many chances of sailing into the typhoon, if Zi-ka-wei weather warnings were not flatly refused at Victoria. See the pamphlet "The De Witte Typhoon," by the Rev. Louis Froc, S. J., page 6.

[3] Special attention is called to the two following: "Organization of the Meteorological System of Japan," composed for exhibition at Columbian World's Fair at Chicago, 1893, and "Organisation du Service Meteorologique au Japon," presented at the Paris Exposition, 1900.

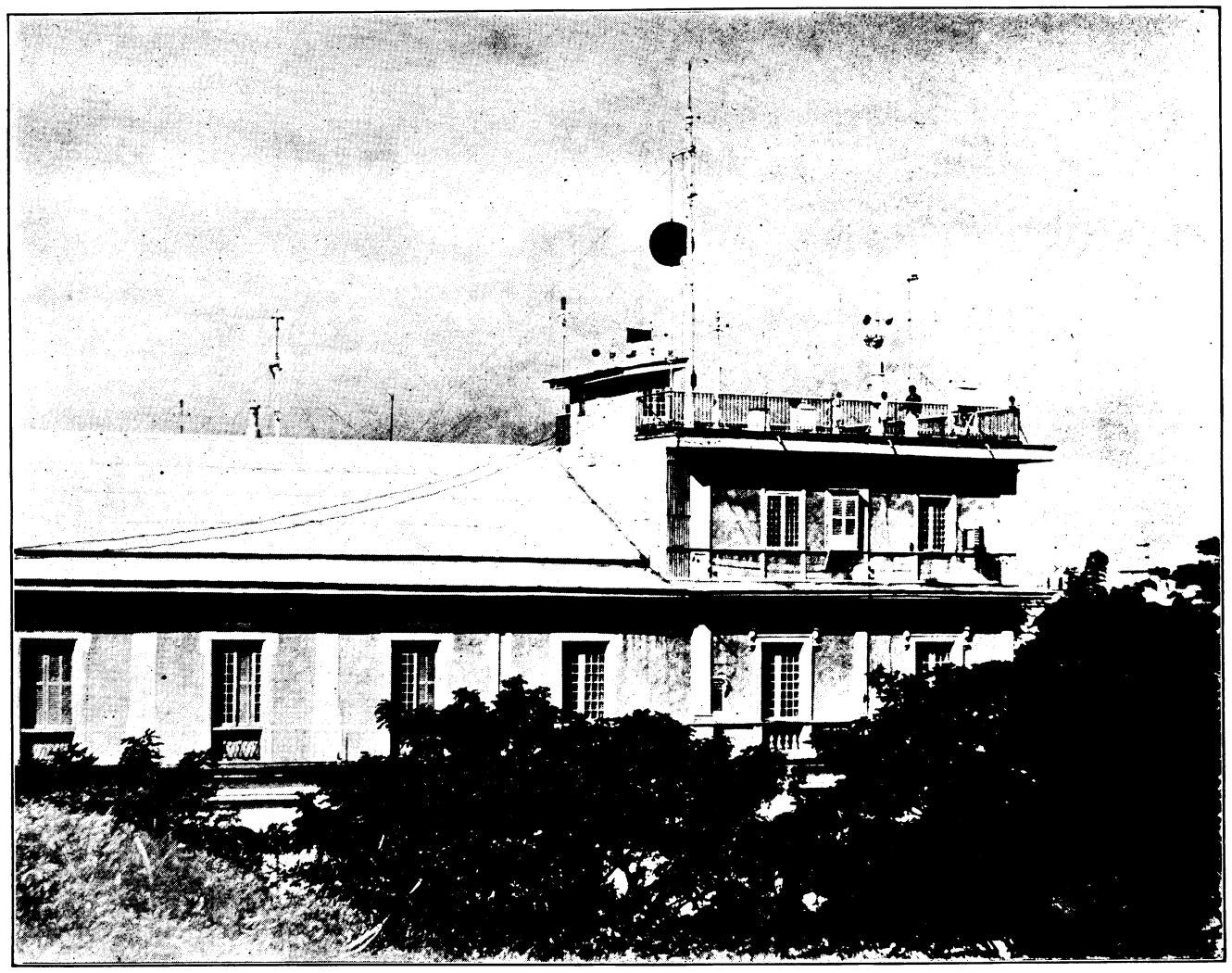

PLATE II.—VIEW OF METEOROLOGICAL TOWER.

IV. THE METEOROLOGICAL OBSERVATORY OF MANILA AFTER ITS OFFICIAL ESTABLISHMENT.

Transfer of the Observatory to the new building which it occupies at present.—As soon as the new building destined for the Central Observatory was finished, the meteorological and seismical apparatus were transferred from the old tower in the Walled City to their new quarters, so that on July 15, 1886, the time ball began to drop at the new position, and by the end of the same month all the instruments had been installed, and were in regular working order. The building stands in the suburb known as Ermita, on slightly elevated ground, and near the sea. It has no immediate obstacle in view, has clear horizons and beautiful and extensive gardens on every side, which, as numerous visitors have occasion to notice, afford not only recreation to the mind, but also an extensive field for all kinds of scientific investigations. On this same piece of property there are two other buildings of more recent construction, each separate from the other and from the main building, one devoted to astronomical, the other to magnetical work. The magnetical department[1] is complete and has been in continuous operation since October 28, 1888, the date of its official establishment. The astronomical department[2] became completely equipped in 1898, when the large equatorial telescope was installed.

Let us return to the principal building. It is rectangular in form and of very solid construction, the walls of the first story being of great thickness and of hewn stone. All around the second story runs a gallery, which on the one hand serves to protect the rooms from the direct action of the sun and rain, and on the other preserves a mantel of air, which, being renewed regularly by means of sliding blinds, does away with the causes of error, which both the instruments of direct observation and the self-registering ones might suffer from at every abrupt change of temperature.

The meteorological department, prescinding for a moment from the park, of which we shall speak later, is installed in the two large rectangular towers which constitute the corners of the main front of the building. Within the left tower was built an enormous pier of cut stone, for the installation of certain apparatus requiring greater stability, and which rises through both floors, but which is at the same time isolated from them. The apparatus which does not require to be in the open air is found distributed through the two large halls, some affixed to the above-mentioned pier, and the rest to columns round about. On the azoteas on top of the towers are installed the meteorological apparatus for the open air and for the shade. For these last ordinary little huts made of Venetian double blinds are used, a system of shelter, which, considering the location in which they are placed, give better results than the double covering used in other observatories.

At the foot of the principal stairway, and at its side, is the telegraphic station set apart for the use of the Meteorological Service of the Philippines, and which unites the Central Observatory with all the secondary stations and with the cable. Here all the dispatches from the Philippines and from the foreign ports are received, and those of the Observatory transmitted.

Fr. Faura's aneroid barometer.—In speaking of the meteorological work carried on since the Observatory was transferred to its new situation just described, it will not be necessary to mention in detail all the typhoon warnings of the successive years, since this would be too great a task.[3] Hence, we shall confine ourselves to mentioning here some of the more important works accomplished. One of these is the aneroid barometer of Fr. Faura. The inventor presented it, on August 31, 1885, before the *Real Sociedad Económica de Amigos del País,* of which society he was a member. The object of the instrument is expressed in the words used by Fr. Faura when presenting it: "I published in 1882 the 'Señales Precursoras de Temporal,' adapted to the intelligence of all, that it might be of service to all who may be exposed, either in their life or interests, to the fury of these

[1] See a detailed description in "El Magnetismo Terrestre en Filipinas," by Fr. R. Cirera, S. J.

[2] See article in National Geographic Magazine, November, 1900, "The Manila Observatory," by the Rev. Jose Algué, S. J.

[3] As all the typhoons whose influence could be felt in the Archipelago were announced to the public, those who wish may consult our monthly Bulletins, or, better still, the special discussions published since 1894, such as: "Baguios ó Tifones de 1894," por el P. J. Algué, S. J.; "Tifones del Archipiélago Filipino y Mares Circumvecinos, 1895–1896," por el P. J. Doyle, S. J.

storms, and who could not receive in time the warning of the observatory. But desirous of spreading abroad still more the fruits of my labors, I believed that the best means to accomplish this would be to engrave on the barometers that are more easily managed and more frequently used in the Archipelago, a compendium of said rules all made plain to the sight by means of the movements of the needle. In this consists the whole modification in the barometer, which I have the honor to offer to the society. I beg that before judgment be passed upon it, it be subjected to trial. A small pamphlet explanatory of its indications should accompany the instrument, but not having quite finished the pamphlet, and not wishing any longer to delay the presentation of the instrument to the society, I sent it without the pamphlet. When I shall have finished the latter, I shall have the honor of adding it to the instrument." The pamphlet to which Fr. Faura alludes is entitled "El Barometro Aneroide aplicado á la previsión del tiempo en el Archipiélago Filipino," which he published for the first time in 1886.

The advantages resulting from the use of the aneroid barometer of Fr. Faura, and the high appreciation in which it is held by the public, can not well be exaggerated. It has come to be so popular, and has been so generally accepted in these latitudes, especially throughout the Archipelago, that there was not a ship captain who did not carry one; it will be found in the offices of all the commercial houses, and innumerable private persons have it in their homes as the best guaranty of safety against the fury of the typhoons.

The Observatory takes part in various expositions.—Passing by the work which the Observatory contributed to the Universal Colonial Exposition of Amsterdam, inaugurated on May 1, 1883, and the recognition which the work received from the executive committee by a diploma of honor,[1] let us take a look at its work at the Exposición Filipina, held in Madrid, and beginning in June, 1887. The following objects were exhibited: The barometer of Fr. Faura, ten volumes of the "Boletin Mensual," another volume which contained a description of the Observatory, of all its apparatus, and a report of the meteorological service, and, finally, two large albums containing views and drawings of apparatus, plans, meteorological and seismical curves. The prizes obtained by this display were, a diploma of honor, and a gold medal offered to Fr. Faura as Director of the Observatory.[2]

In 1893 the United States Government resolved to celebrate, as the finishing touch to the celebrations in which America had just taken part in honor of the memory of Christopher Columbus, the World's Columbian Exposition of Chicago. In the midst of this splendid manifestation of the arts and of the industries, various scientific congresses were held, to which the Director of the Manila Observatory, Fr. M. Saderra Mata was officially invited. Having accepted the invitation, and not being able to absent himself from Manila, on account of being engaged at the time with the service of typhoon warnings, he sent a work entitled "Thunder-Storms in Manila," and the well-known meteorologist Fr. Faura, and Fr. José Algué were sent to represent him. The previous residence of the last-mentioned Father in the United States for over two years had given him an opportunity to become fully conversant with the state of meteorological studies in that country, and to come into personal relations with the most eminent students of the science both in North America and in the Antilles. By a royal decree of July 15, both the above Fathers were commissioned to represent the Spanish Government at the Congress at Chicago. They arrived there shortly before August 29, the date appointed for the opening of the scientific and philosophical congresses. There is no need of stopping here to speak of the part taken in the Congress by the Spanish delegates; those who wish may consult the interesting memorial they published on their return to Spain.[3] Besides the work above cited, Fr. Faura presented his own "Señales Precursores de los Tifones en el Archipiélago Filipino," and another of Fr. Ricardo Cirera, S. J., "El Magnetismo Terrestre en Filipinas."[4]

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[1] See the "El Comercio" of Manila for June 9 and 20, 1883.

[2] See the remarks concerning these prizes in the "La Oceania Espanola" of Manila for November 16, 1887.

[3] "La Meteorologia en la Exposición Columbiana de Chicago, 1893. Memoria escrita por los PP. Federico Faura y José Algué, comisionados del Gobierno Español." It contains, besides the official communications, a résumé of the whole order of the Congress, of the works presented, and of the subjects discussed in the various sessions.

[4] See "Report of the International Meteorological Congress, Held at Chicago, Ill., August 21–24, 1893," Page IX.

On April 4, 1900, a communication was received, in which the Manila Observatory was invited to assist at the International Meteorological Congress at Paris, which was to take place in September, from the 10th to the 16th, in connection with the Universal Exposition. The Honorable President of the Commission of the United States in the Philippines, Mr. W. H. Taft, thought proper to send, as representative of this Government, Fr. Algué, the actual Director of the Observatory, who, at the request of the members of the Congress, brought before them his new apparatus, the barocyclonometer. He presented also a recent work: "La Actividad Séismica en el Archipiélago Filipino en el año 1897," by Fr. José Coronas, S. J. For details of this representation one may consult the publications relative to the Congress.[1]

Finally, in February, 1902, the French Consul at Manila solicited the coöperation of the Observatory in the Colonial Exposition of all the extreme East, which was to take place at Hanoi, the capital of Tonkin, during the following November. It has been resolved to present some of the more recent publications, together with the descriptive chart of the new meteorological service of the Philippines.

Cooperation in other international works.—Passing by the part which, in union with many other scientific centers throughout the world, the Observatory took in the ten years' simultaneous meteorological observations from 1878 to 1888, we shall say a few words now of its coöperation in the international work of cloud measurement.

Toward the beginning of November, 1895, a communication was received from Mr. Robert H. Scott, Secretary of the International Meteorological Committee, in which communication the Observatory was invited to coöperate in the work of cloud measurement, which was to continue for the space of an entire year. In view of the great importance of this work to meteorology, the invitation was accepted. The Manila Observatory was, consequently, included in the sixteen central observatories which took part in this great international labor of the determination of the general movements of the atmosphere over the whole earth, by means of precise measurements of the height, velocity, and direction of the clouds.

As soon as possible, an order was given to the instrument-maker, Mr. O. Gunther, of Potsdam, Germany, for two phototheodolites of exactly equal construction, for the use of our Central Observatory. Besides these, two French phototheodolites, constructed by Charles Echassoux, Secretary of the Central Meteorological Office of France, were used in the work.

The photographic observations were begun in Manila on time, and in accordance with the form and system agreed upon, the start being made on June 1, 1896. This whole labor fell to the lot of Fr. J. Algué, then Subdirector of the Observatory, who published the results of his investigations in the important book which bears the title: "Las Nubes en el Archipiélago Filipino."[2] Of it Mr. H. H. Hildebranson, in a letter to Fr. Algué, dated June 19, 1899, thanking the author for the copy of the book which he had just received, says: "Your Reverence's publication of the observations of clouds during the period of 1896–97, is the first to appear complete at the present time. I beg you to send me another copy, that I may present it to the International Commission, which is to meet in St. Petersburg on the 2d of the coming September." And in a later letter of September 22, the same gentleman says: "Your publication has been received with great favor, and with the liveliest enthusiasm by all the members of the International Commission assembled at St. Petersburg, especially when it was remembered under what great difficulties you brought this important work to such a successful issue."

The Algue and Bergholz barocyclonometers; books of both authors on cyclones.—Toward the end of 1897 Fr. Algué published his book in Manila on cyclones,[3] in which he explained, in the first

[1] "Congress International de Meteorologie, Paris, 1900," by M. Alfred Angot, pages 13, 33, and 131.

[2] This work contains, besides the communications of the International Meteorological Committee, and the proceedings of the Commission of the Cloud Atlas gathered at Upsala, the description of the principal nephoscopic apparatus, and explains in detail the methods employed in the photogrammetry of the clouds; it gives finally all the results obtained, in a series of numerous tables of the direct, mean, and extreme values.

[3] The entire title is "Baguios ó Ciclones Filipinos. Estudio teorico-práctico por el P. J. Algué, Director del Observatorio. Manila, imprenta privada del Observatorio, 1897."

part, the theory of the body of the cyclone, in the second the precursory signs of a cyclone, while the third contained a classification of the cyclonic storms observed in these latitudes, the author noting at the same time certain irregularities and exceptions, which had been noticed at times.

A book of this nature, theoretical and practical at the same time, ought evidently to be of great service to the pilots who frequent the tropical seas, and in general to all those who have important interests in the colonies of the extreme east. Wherefore, it is superfluous to state that it has been highly esteemed since its very first appearance, and that it has received a grateful reception from members of the commercial and mercantile companies. It was published in French in 1899[1] for the French Hydrographic Service, and others asked permission to translate it into English and into Japanese.

Dr. Paul Bergholz, Director of the Observatory of Bremen, Germany, also earnestly asked permission to translate and publish it in German. Permission was given by the author, and the book appeared before the public in 1900, under the title: "Die Orkane des fernen ostens, von Prof. Dr. Paul Bergholz." Let anyone who cares to do so, turn over page by page the book of Bergholz, with Fr. Algué's book in the other hand, and he will see that the former is the same, even as to titles, paragraphs, and plates, as the latter, if we except a small portion taken in the same way from certain publications of the Jesuits, who direct the Observatory of Zi-ka-wei. True it is, Dr. Bergholz makes honorable mention of Fr. Algué in the prologue which he puts to his production, but, who is there that can not see that this gives him no right to come forth as the author of the contents of the book, or even to appear to do so?[2]

But this is not all. About this time Fr. Algué brought out his barocyclonometer, which, as its name indicates, consists of two parts, a barometer and a cyclonometer. Concerning the first, the author says, in the preface of the explanatory pamphlet,[3] "There are two main reasons, which have moved me to labor at the construction of the new apparatus which this little work describes. The first is the consideration of the great convenience, not to say necessity, of a barometer which may be of service indifferently in all latitudes of the extreme East, seeing now that the exigencies of traffic and commerce on the one side, and the manifold interests of an international character on the other, are each day opening new paths to our navigators, as well in the navy, as in the merchant marine. And since it is true that in these seas the meteorological elements present such different characters, that it happens, at times, that the mariner encounters in a single trip normal barometric heights so different as 754 mm. and 758 mm. in the short distance which separates Hongkong from Manila, and 771 mm. and 759 mm. between Chefoo and Iloilo, it becomes altogether impossible to apply in such cases the fixed notes that are usually found engraved on the faces of the barometers, even in the case of the best of those accomodated to conditions here, such as the popular barometer of Fr. Faura, which is only meant for the reduced zone of this Archipelago.

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[1] It was first published in the Annales Hydrographiques, 1899; an extract was made from it in 1900, which bore the title, "Les Cyclones aux Philippines et dans las mers de Chine. Etude theorique et pratique por le Pere José Algué, Director de'l Observatoire de Manille." (Le travail original á été arégé et modifié dans certaines parties.)

[2] In connection with this, in an important German review the following amendment has been recently (September, 1902) published:

"Correction on the report made by the undersigned in the series of Petermann's Mitteilungen, 1901, under No. 25 in the Litteraturbericht concerning Bergholz, P.; Die Orkane des fernen Ostens, 8vo., 260 pp., mit 31 Taf. und 7 Abb. im Texte. Bremen und Shanghai, Max Nössler, 1900.

"The preface of this book contains the remark that the book is '*based*' upon J. Algué's Baguios ó Ciclones Filipinos, Manila, edited in 1897. This remark was not sufficient to make the undersigned think that the present book was merely an abbreviated translation of the Spanish book. We regret, however, to be obliged to state that the remaining part of the preface of the German book creates the idea that the book is original and only based upon the Spanish book among others.

"It is to be sincerely hoped that a new edition of Bergholz's book will even from its outside appearance show the character of the book to be a 'translation' only. Potsdam, Magnetic Observatory, August 25, 1902. A. Nippoldt, jr."

[3] The title is that of the name of the instrument: "El Barocyclonometro."

"The other reason, none the less weighty than the first, is that I have been sorry to observe, that the popularity of Fr. Faura's barometer has led some instrument-makers to counterfeit the above aneroid in such a way, that the observer is frequently found to possess, in place of a trusty instrument of precision, such as he should have, nothing but a hardware toy which would be calculated to discredit the arrangement of the indications and notes on its face, were not the reputation, which they have, so well founded.

"As far as the cyclonometer is concerned, which is altogether original, it suffices to say that it represents graphically the lower section of the body of a cyclone, in such a simple practical manner, that it may truly serve as a guide to pilots, even when, owing to the presence of danger, they may be laboring under excitement and anxiety."

The construction of the apparatus was intrusted to the German house of G. Lufft, of Stuttgart, and the first dozen samples reached Manila toward the end of 1898, where they drew forth the merited approbation of the public.[1]

But, lo and behold, Dr. Paul Bergholz, no doubt a very active man, and apparently ambitious of glory, thought he saw a good thing in the above-mentioned apparatus, and so, applying to the same constructor, he came to an agreement with him that he should construct the Bergholz barocyclonometers, which were to be identical with those which he had been constructing for Fr. Algué, with this only difference, namely, that the notes engraved on the face of the instruments were to appear in German. And in this manner the director of the Observatory of Bremen did not hesitate to appropriate the Algué barocyclonometer, take out a patent for the invention from his Government, and sell and announce it as his own, appearing before the face of the whole world[2] with laurels not so much borrowed as rather snatched away from a competitor who, not looking for such forms of glory, but rather satisfied with the real merit of having conferred a favor on the public, has not wished, even up to the present, to protest, though a magnificent occasion was offered at the recent Paris Exposition. Certain it is that Fr. Algué does not hold any document accrediting him with the exclusive right of the invention, though he asked such of the Spanish Government; for, the petition in which it was asked according to due form, was unfortunately lost, we know not how, in the offices of Manila; and at present the grave occurrences which have befallen these Islands leave no opportunity for repeating the petition. Still all this scarcely justifies Dr. Bergholz in what he has done; neither do we vindicate for Fr. Algué a positive right which he does not possess, but we do take pleasure in setting forth the truth before all, that no one may attribute complete silence on this subject to stupidity.

Something still remains to be said. Another very respectable person, Dr. Robert H. Scott, F. R. S., for many years the secretary of the International Meteorological Committee, has just published a translation in English of Bergholz' work already mentioned. It is called "The Hurricanes of the Far East, by Prof. Dr. Paul Bergholz. English translation revised by Dr. Robert H. Scott, F. R. S." Within a short time past Bergholz barocyclonometers, English form, have appeared; these we can in no way distinguish from the genuine Algué instruments of the English form, which have been coming to Manila for some time. Withal, Mr. Bergholz will say that they are unquestionably his, basing his claim on these two powerful reasons, which he gave to the constructor, when the latter made some objection to doing the work for him: "First, he was appropriating the Algué barocyclonometer with the same right that Algué had in appropriating the Faura barometer; secondly, the Bergholz apparatus had something new, as far as the notes on the face were concerned." And in truth, no other modification could have been made, seeing that Bergholz, eminent man though he be, has no more experience of typhoons than what he has acquired from books, never having been, as far as we know, in these latitudes.

The observatory and Mr. Doberck.—Under this head we do not include the series of unjust attacks, at the hands of Mr. Doberck, of which the Jesuits who direct the observatories of Zi-ka-wei

[1] The importer of the apparatus is D. Enrique Spitz, Escolta, 42, Manila, who has agents in Singapore, Hongkong, and Shanghai.

[2] The book of Bergholz and his barocyclonometers are accepted throughout almost the whole German navy and merchant marine.

and Manila have been the repeated objects since the year 1884; but we refer only to the attack of this director of the Observatory of Kowloon, Hongkong, against the directors of the Manila Observatory toward the end of the year 1898. The very grave charge openly made against them has been so completely and victoriously proved to be false by the unanimous testimony of respectable public opinion that it would be useless to attempt to refute it anew. We desire, nevertheless, to make a brief record of the facts here, such as the present nature of our work, namely, the historical review of the Philippine Meteorological Service, requires, and also in order to uphold the cause of truth.

The Director of the British meteorological service at Hongkong, taking advantage of the grave circumstances in which the Islands had been placed, since the 1st of May, 1898, sent a letter to the United States Minister of Agriculture, speaking in the most unfavorable terms of the Directors of the Manila Observatory, calling the attention of the Government in a special manner, to the general commotion, which, as he said, was frequently caused by the alarming typhoon warnings sent out by the Manila Observatory, and published by the papers of the neighboring colony. The immediate effect of this accusation was an order from the United States Minister of War, that henceforth all typhoon warnings sent by telegraph from Manila outside the Archipelago should be suspended. This official order was communicated to the Director of the Observatory on February 27, 1899, and from that moment all the typhoon warnings referred to were suspended. In view of the above, Fr. Algué addressed a circular to the most prominent persons in the extreme East most interested in the affair, stating the simple facts as they stood, and asking them to please give him their opinion of the services which the Observatory of Manila had been offering to the public during the past years, and especially their judgment on its typhoon warnings.

The indignation which the news of Mr. Doberck's calumny called forth, and its immediate effect on the Manila and Hongkong press, in naval and mercantile circles, and in general among all the dwellers in the extreme East, may be seen by the reader in the collection of documents, which were given out to the public about the middle of 1899, under the title: "El Servicio Meteorologico del Observatorio de Manila vindicado y rehabilitado.[1] He who reads the spontaneous declarations made by all of authority and weight, will see with what terms they qualify the conduct of Mr. Doberck, and what the public thinks of his services when compared with the meteorological service offered by the Manila Observatory.

We shall quote but one testimony, that of the Hongkong Chamber of Commerce. This corporation was much concerned at the suspension of the Manila typhoon warnings, and spontaneously took action on the matter, as is shown in the following correspondence:

Letter of the Hongkong Chamber of Commerce to the Colonial Secretary.

HONGKONG GENERAL CHAMBER OF COMMERCE,
Hongkong, March 21, 1899.

SIR: This Chamber has received a letter (with inclosures) from the Director of the Manila Observatory, of which the inclosed is a copy, and in which complaint is made of a communication addressed by the Director of the Hongkong Observatory to the Weather Bureau of the United States Government as seriously reflecting on the value of the typhoon warnings supplied to Hongkong by the Manila Observatory.

The experience of the committee and of the commercial community is that the telegrams giving warning of approaching or expected typhoons furnished by the Manila Observatory have been most useful, and the chamber and the commercial community would view their discontinuance with extreme regret.

The committee would be much obliged if the Government will kindly favor the chamber with a copy of the letter addressed by the director of the Hongkong Observatory to the Weather Bureau of the United States Government.

I have the honor to be, sir, your most obedient servant,

R. CHATTERTON WILCOX, *Secretary.*

Hon. J. H. STEWART LOCKHART, C. M. G., *Colonial Secretary.*

[1] It contains, in addition to the official documents called forth by the ill-timed attack, the following articles: "Attitude of the Manila Observatory," "Judgment of the press," "Opinion of the commercial and maritime circles," "Declarations of various consuls," "Replies of the Naval Departments and Captains of Ports," "Testimony of admirals of squadrons in the extreme East." "Action and protest of the Observatory of Zi-ka-wei," "Action of the Chamber of Commerce of Hongkong," "Intervention of the Colonial Government of Hongkong, and the revocation of the order forbidding the sending out of warnings beyond the Philippines," "Conclusion," "Appendices."

Letter of the Colonial Secretary to the Chamber of Commerce.

COLONIAL SECRETARY'S OFFICE,
Hongkong, March 24, 1899.

SIR: I am directed to acknowledge the receipt of your letter of the 21st instant and its inclosure on the subject of typhoon warnings from Manila, and to state that the matter is engaging the attention of this Government.

I will communicate further with you in due course.

I have the honor to be, sir, your most obedient servant,

J. H. STEWART LOCKHART,
Colonial Secretary.

The SECRETARY, *Chamber of Commerce.*

Letter of the Colonial Secretary to the Chamber of Commerce.

COLONIAL SECRETARY'S OFFICE,
Hongkong, March 28, 1899.

SIR: In continuation of my letter, No. 485, of the 24th instant, I am directed to state for the information of the Chamber of Commerce that the request made by the Director of the Observatory to the Chief of the Weather Bureau at Washington, United States of America, for the discontinuance of typhoon warnings from the Manila Observatory was not authorized by this Government.

Dr. Doberck acted under the belief that he had for several years the necessary authority for his communication to the Chief of the Weather Bureau at Washington. His mistake has been pointed out to him. Intimation has been made to the Military Governor of the Philippines that the request was unauthorized, and a hope expressed that the order for the discontinuance of the meteorological information would be rescinded. The Military Governor has also been informed of the appreciation of your chamber of the warnings sent from time to time.

I have the honor to be, sir, your most obedient servant,

J. H. STEWART LOCKHART,
Colonial Secretary.

The SECRETARY, *Hongkong General Chamber of Commerce.*

Letter of the President of the Hongkong Chamber of Commerce to the Director of Manila Observatory.

HONGKONG GENERAL CHAMBER OF COMMERCE,
Hongkong, April 18, 1899.

SIR: I beg to acknowledge receipt of your letter (with inclosures) of the 7th ultimo in which you inform this chamber that, in consequence of the Director of the Hongkong Observatory having addressed the Weather Bureau of the Government of the United States of America in very unfavorable terms relative to the Manila Observatory, accusing the Directors of sending "sensational typhoon warnings to the newspapers in Hongkong," instructions have been given you to discontinue the dispatch of typhoon warnings to any place outside the Philippines

Your letter was considered at the meeting of the general committee held on the 20th ultimo, when it was resolved to address the Hongkong Government on the subject before taking action, and copies of the letter with the replies received are now inclosed.

At the annual meeting of the chamber, held on the 5th instant, the Hon. T. H. Whitehead then proposed the following resolution, which was unanimously carried:

"The members of the Hongkong General Chamber of Commerce desire to convey to the Rev. Father José Algué, S. J., the expression of their extreme regret and dissatisfaction at the unjustifiable attack made upon the Reverend Director of the Manila Observatory and his colleagues by the director of the Hongkong Observatory, and to the consequent stoppage by the American Government of the telegraphic meteorological warnings from the Philippines. The members desire to place on record their high appreciation of the very valuable services at all times rendered by the Directors of the meteorological department of the Manila Observatory to the mercantile and shipping community in Hongkong and China, and their hope and expectation that in a very short time full justice will be done the Directors of the Manila Observatory by the acknowledgment of the immense practical value of their labors in the past for the public benefit and in the cause of science, and the restrictions recently placed upon them being speedily removed."

It only remains for me to convey to you and your colleagues the thanks of this chamber and of the whole commercial community of Hongkong for the good service rendered them by the prompt and timely warnings sent by you ever since the establishment of cable communication between Hongkong and Manila, and which we can not doubt have been the means of saving many lives and much valuable property. I must add, in conclusion, that it is the hope of the chamber that the supply of this useful information will soon be resumed.

I have the honor to be, sir, your most obedient servant,

R. M. GRAY, *Chairman.*

The Rev. JOSÉ ALGUÉ, S. J., *Director, Manila Observatory.*

The desired revocation came very soon; the Colonial Government having considered the matter, directed the following letter to the Military Government of the Islands:

COLONIAL SECRETARY'S OFFICE,
Hongkong, March 28, 1899.

SIR: It having been brought to the notice of this Government that in consequence of a request made by the Director of the Hongkong Observatory to the Chief of the Weather Bureau, United States of America, His Excellency the Military Governor in the Philippines has ordered the discontinuance of the transmission of typhoon warnings from the Manila Observatory to Hongkong, I am directed to state that the request of the director of the observatory in this colony was unauthorized by this Government and that the mercantile community have intimated through the local chamber of commerce their appreciation of the telegraphic warnings conveyed by the Manila Observatory and the extreme regret with which they would view their discontinuance.

Under the circumstances I hope that the order for the discontinuance of meteorological intimation may be rescinded.

I have the honor to be, sir, your most obedient servant,

J. H. STEWART LOCKHART,
Colonial Secretary.

To the SECRETARY OF THE MILITARY GOVERNOR IN THE PHILIPPINES.

The said order was revoked on April 3, 1899, and from that date forward the transmission of typhoon warnings to points outside the Islands was again resumed, much to the gratification of those in Hongkong.

V. APPARATUS AND WORK AT THE CENTRAL METEOROLOGICAL DEPARTMENT AND ITS RELATIONS WITH OTHER CENTERS IN THE FAR EAST.

Before referring to the official dispatches and the daily work carried on at the central office, we shall proceed to describe both the self-recording instruments and those for direct observation, which are used there in taking the observations. But as the majority of them have been noticed in the various Monthly Bulletins,[1] and as, moreover, they are at the present day sufficiently well known, for there are various available publications in which they are described, we shall, with the exception of a few which we shall describe later on, simply enumerate the instruments in the form of a catalogue.

APPARATUS OF DIRECT OBSERVATION.

Two large standard barometers, one of the Fortin pattern, made by Casella; the other with a fixed bulb and movable scale, made by Negretti & Zambra. Both were tested in the observatory of Kew. The tube measures 17.5 mm. interior diameter.

Other mercurial barometers, Fortin & Tonnelot, for ordinary use. Several aneroid barometers of Fr. Faura and barocyclonometers of Fr. Algué.

A compensating mountain barometer, of 12 centimeters diameter, for measuring from 1,000 to 5,000 meters.

One standard thermometer, made in France, with a scale divided into tenths of degrees.

Another standard thermometer, Kuchler.

Standard thermometers, maximum and minimum, from Fuess (Berlin).

Various other simple maximum and minimum thermometers from Negretti & Zambra.

Apparatus for determining the 0° and 100° points of thermometers.

Apparatus for comparing thermometers.

One standard Fuess psychrometer.

One condensation hygrometer, Regnault.

One photopolarimeter, M. A. Cornu.

One thermohygroscope and weather telegraph (Lambrecht), to announce storms and changes of weather.

One psychrometrograph of aspiration, Lambrecht.

One Lambrecht polymeter, to observe the temperature, humidity, and vapor tension.

[1] See description of various apparatus in the beginning of volumes for 1870, 1887, and 1890.

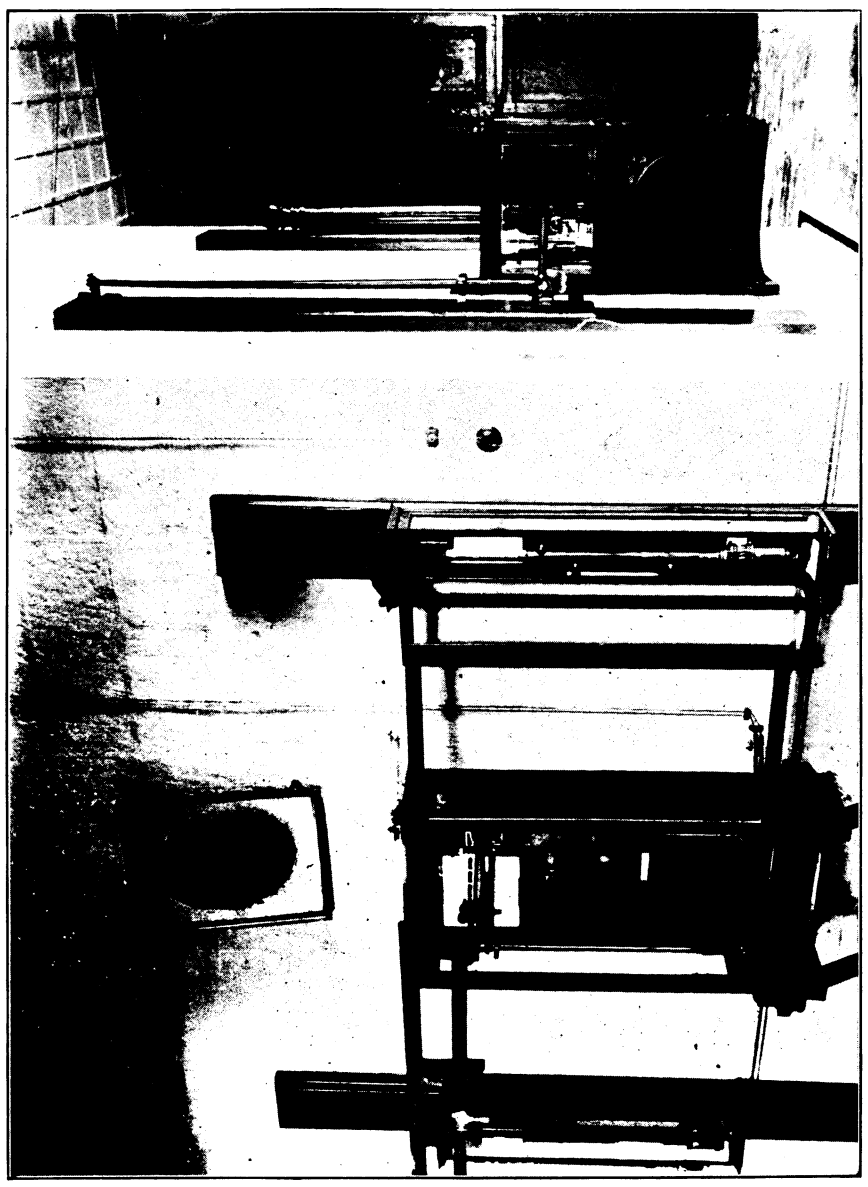

PLATE III.—INSTALLATION OF THE APPARATUS IN THE METEOROLOGICAL TOWER.

PLATE IV.—THE ALGUE NEPHOSCOPE IN USE.

Several Robinson anemometers and wind vanes.
Two traveling anemometers, Fuess and Richard.
One Wild anemometer.
One nephoscope of Fr. Cecchi.
Two Fineman nephoscopes.
Two French photogrammeters constructed by Charles Echassoux, and two other German photogrammeters, constructed by Gunther, of Braunschweig.
Two pluviometers, Symonds & Grosly, and others of different types.
Several Piche vaporimeters.
One ozonometer, Clarke.
One Arago actinometer.
One hygienic-meterologic observatory.
Shelter for the thermometers and hygrometers (Montsouris type).
Shelter for thermometers and hygrometers (Fuess type).
Aspirating pump for comparing aneroids.

SELF-REGISTERING APPARATUS.

Fr. Secchi's universal meteorograph, which has been in operation in Manila Observatory since 1869.
One barograph, Sprung-Fuess.
Several Richard barographs of large size.
Several Richard thermographs.
Two Richard terrestrial thermographs.
Several Richard psychographs.
One Richard hygrometrograph.
One Richard anemograph, which records electrically the velocity of the wind and mechanically its direction.
One Beckley anemograph, Negretti & Zambra.
One Garrigon-Lagrange clino-anemograph.
One Richard pluviograph.
One Casella pluviograph.
One Whipple-Casella universal heliograph.
One Richard heliograph.
One Thompson electrometer, modified by Mascart, with photographic register for observing atmospheric electricity.

Latest refraction nephoscope.—The instrument which we are about to describe is the latest refraction nephoscope, invented by Fr. José Algué, who, during his sojourn at the Paris Exposition of 1900, put the model for construction in the hands of E. Ducretet.

The exterior form, as may be seen in the plate (IV), is that of a truncated cone, suspended from an axis which traverses at right angles the neck in which the cone terminates. About this axis the cone may be made to turn in order to elevate it more or less, according to the altitude of the cloud to be observed. The cone may be fixed in any of these positions by means of clamping screws. At two opposite points in the walls of the cone there are orifices, through either of which the observer may take a sight of the real image of the cloud on the base, which latter may be of ground glass, parchment, or other similar substance. This real image comes from the lens which closes the end of the cone. The lens measures 8 centimeters in diameter. The lens may be diaphragmed at will, in order to regulate the amount of light let through. The axis of the cone rests on two small columns fixed upright upon a revolving disk. The disk revolves directly over the base, which is provided with three leveling screws and a spirit level. The fixed disk bears the degrees of the circumference and the principal points of the compass. The movable disk is provided with four engraved lines, which correspond in direction to two diameters of the lens at right angles to each other, and which serve to show on the fixed disk the position, in reference to the cardinal points, of the two diameters in any given position.

So constructed, the apparatus is used to find the direction of the clouds and their relative or apparent velocity; with this data the real velocity may be very easily deduced, if we know the altitude of the cloud under observation. This altitude is obtained from data already known, namely, the mean height of the different types of clouds, which we know from photogrammetric measurements made in pursuance of the international work of cloud measurements already mentioned.

We say that it is found very easily. For example:

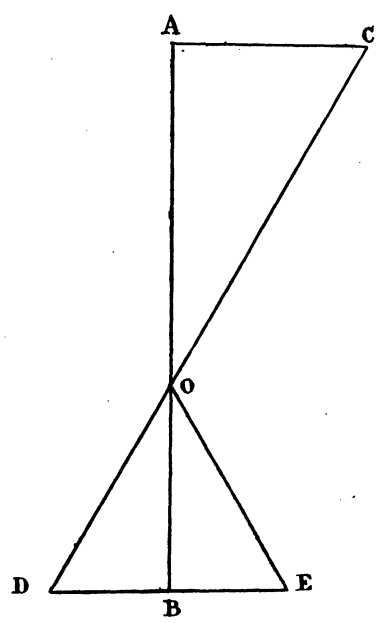

FIG. 1.

In the accompanying figure (fig. 1) let O be the focus of the lens; AO, the altitude of the cloud; C, the point of the cloud under observation, which has its image at D. It may be noted that DE is equal to OB by construction. This being supposed, we say, if we know the altitude of the cloud, we know its real velocity. Since, from similar triangles

$$\frac{AO}{OB}=\frac{AC}{DB}$$

Hence, we know AC in functions of OB, AO, and BD. BD is the space passed over on the ground glass by the cloud, in the definite period of time determined in each observation. And as the velocity is equal to the space divided by the time, $V=\frac{S}{T}$, we have obtained the real velocity which we were looking for.

The above operation can be remembered with ease; the ground glass space DE (fig. 2) and the diameter perpendicular to DE are divided into ten equal parts by means of parallel lines, resulting in a number of small equal squares on the base of the cone.

Now, since the side of each square is $\frac{1}{10}$ of OB by construction, as we have just said, it will be seen that, in order to find the real velocity of the cloud, it will be sufficient to divide the tenth part of the mean height of the cloud observed, by the number of seconds taken by the image of the cloud to traverse one little square; hence, according to the arrangement of the reticulated surface, the above equation may be thus expressed: $V=\frac{\frac{1}{10}AO}{T}$.

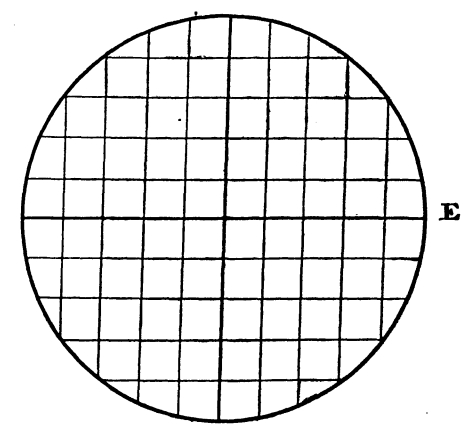

FIG. 2.

It is not less easy to observe with this nephoscope the direction of the clouds. Thus, to take such an observation, the instrument is oriented by means of the magnetic needle affixed to the movable disk. The disk is made to revolve in such a way that the directions of the needle coincide exactly with the inverse directions of the fixed platform. This is convenient, because of the fact of the real image being inverted. The cone is adjusted in such a position that the image of the cloud enters the field of vision on the ground glass, and applying the eye at one of the lateral orifices, the apparatus is then moved in azimuth until the image of the cloud runs along one of the parallel lines of the ground glass. When this is secured, the direction can then be read from the fixed disk.

Compared with other nephoscopes, this apparatus has this disadvantage, that in the image some of the light is lost, and the image is smaller than the object. But, on the other hand, it offers many advantages that are considerable. The first is that the image that passes through the field being the real image, there is, even when measuring the lower clouds, no room for the error of perspective which must be reckoned with in ordinary nephoscopes. Secondly, there is greater convenience in

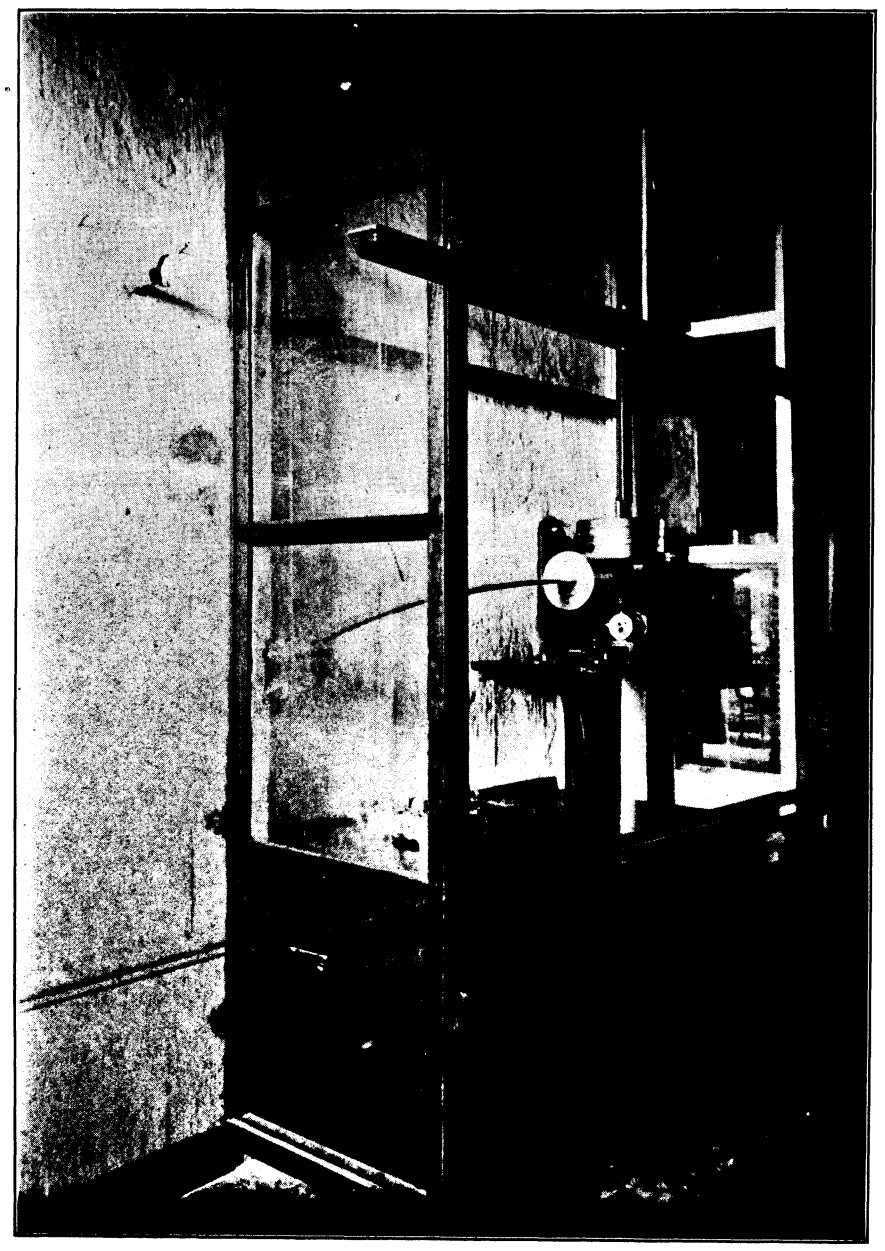

PLATE V.—THE INSTALLATION OF THE VICENTINI SEISMOGRAPH.

having to observe only the image of the cloud, without the need of bringing into coincidence, in the line of sight, the center of the mirror and the end of an upright bar; and for the same reason the observer may withdraw his sight as often as he likes from the nephoscope described, without the trouble of looking anew for his line of sight. The third is the facility with which the real velocity of the cloud is found, as was explained above.

The ceraunograph.—This new instrument is for registering lightning, as the name itself signifies, κεραυνός, a name given to it by the Rev. Fr. Odenbach, S. J., Director of Ignatius College Observatory, of Cleveland, Ohio.

We will first say a few words about the history of the instrument. Since the discovery of the existence of electro-magnetic radiation emanating from disruptive discharges of electricity whose velocity in space has proved to be that of light and whose waves follow the same laws of interference, reflection, refraction, and other phenomena of light, Lodge and Marconi have developed the "coherer," an instrument devised to detect the passage of electro-magnetic waves.

The efforts of some master-minds were soon directed to turn this new force and the "coherer" to some practical use. The first result was its successful application to wireless telegraphy by Marconi. The fact that disruptive discharges like lightning send out these electro-ether waves, naturally led meteorologists to consider this new force and instrument in connection with electric storms. Their efforts have met with success, which leads us to expect that electro-magnetic waves and the coherer will become in time a very valuable adjunct to every meteorological and life-saving station, especially in countries in which the dreadful tornado is likely to rage.

The first attempt made in the Philippines of a practical application of electro-magnetic waves has been carried out with the most encouraging results, and it is now a fact that in our Observatory lightning is harnessed just as the wind, temperature, sunshine, and pressure have been harnessed and forced to record their own doings. The instrument has been used in the meteorological service since August 24 last.

The instrument has been constructed in Kalocsa (Austria-Hungary) under the supervision of Rev. Fr. Fenyi, S. J., director of the Kalocsa Observatory and belongs to the type of a similar instrument devised by Rev. P. Jos. Schreiber, S. J., of the Kalocsa Observatory. The various parts of the instrument, all told, are: A coherer, an alarm bell, a coil with one magnetic needle, two batteries, and a recording disk. The copper collector consists of a copper horizontal insulated wire uniting the towers of the Observatory. The coherer consists simply of two steel wires adhering to each other in the form of a cross. The coherer and the coil with its magnetic needle are worked by a battery of Meidinger type (one element) with proportionate resistance. The battery below described, however, gives better results than the Meidinger type. This battery consists of a solution of salt in which is immersed a bar of iron and another of copper. The current given is very weak and does not become polarized. The coherer is also connected with the collector and with the earth through a lightning wire. Four Leclanche elements work the alarm bell whenever the electro-magnetic waves are received on the collector and the conerer becomes a good electric conductor, and then the magnetic needle is worked by the coil and closes the Leclanche current, moving the electro-magnet which registers on the disk. We have then the result that the Leclanche circuit depends on the Meidinger one, and this in turn upon the coherer. The vibration of the coherer through the movements of the alarm bell restores the coherer to its first conditions of non-conductor, ready to be acted upon by a new electro-magnetic wave.

The distance from which the flash through its electro-magnetic waves may affect the coherer is supposed to be no less than some 50 miles. Experiments to increase the sensitiveness of the coherer are being made, and it is expected that very soon we will be able to register a flash of lightning some 150 or 200 miles distant.

The Vicentini microseismograph.—To the meteorological apparatus already referred to we may add the microseismographic apparatus which are employed in this Observatory, to observe not only the microseismic waves of an indigenous character, but also to give indications of the weather, since

these waves show the progress of cyclonic storms, their position and probable distance from Manila;[1] and thus, both in normal and abnormal weather, the state of agitation of the waters in the neighboring seas, as well as the force of the winds, may be deduced from the microseismic movement.

We will only mention here the Vicentini universal microseismograph, which consists of two heavy masses, one for the vertical component and the other for the two horizontal components perpendicular to each other. The whole apparatus is firmly fixed to a solid column of masonry (Plate V). This enormous column, as is said in another place, is in the center of the left tower of the building and rises through the first and second stories, being, however, quite isolated from them. Since February, 1902, the apparatus has been working in perfect order, giving excellent results, as is proved by its registering very distant earthquakes, among others that of Mexico and Guatemala, which was recorded with an amplitude of 3.9 mm.

With respect to the different parts of the apparatus it is not our intention to describe them minutely,[2] but merely to give a rough outline of them and some particular data. The point of suspension of the pendulum, whose mass is 100 km., is fixed at 10 meters above the ground, the length of the pendulum being 1.50 meters. The arm of the pendulum consists of an iron tube, at the upper end of which is a fine steel wire.

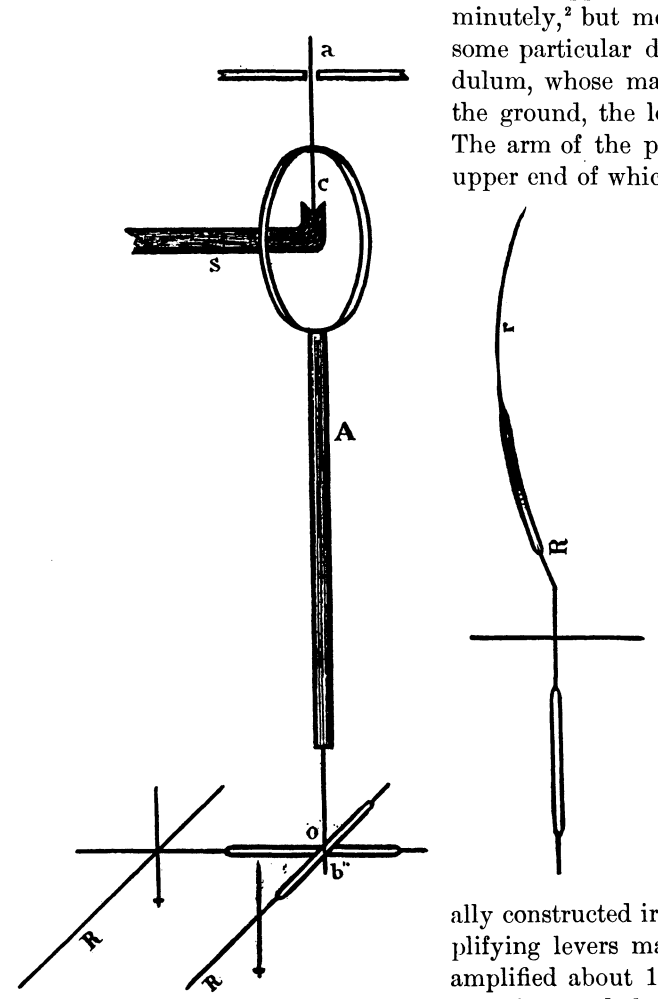

FIG. 3.

The amplitude of the swing of the pendulum is magnified by a series of aluminum levers, the arrangement of which may be seen in the adjoined figure 3.

The vertical amplifying lever A is fastened at its upper end *a* to the bob. The point *c* rests on the support S, which is fastened to the wall. The lower end *b* is connected with the needles at the point O. The pen *r* is made of glass and is joined to the arm of the lever R with wax. The magnifying power of the pens is about 100 times, and the amplitude of the trace of 1 mm. on the paper is equal to 1.5″ of arc.

The smaller mass of the apparatus is fastened to the extreme end of a strong steel spring, which, on account of the position it is forced to take by the weight of the mass, is very sensible to any vertical movement. The steel spring is firmly fixed to the wall by means of a specially constructed iron bracket. The arrangement of the amplifying levers may be seen in figure 4. The movement is amplified about 112 times. In our improved instrument it must be noted that the pivots of the pens rest on screws, by means of which they may be adjusted with great accuracy. The pens make a trace on a continuous band of smoked paper, which is driven by clockwork round a drum in a spiral so that the traces of the pen shall not be on top of one another. The paper can

[1] See the Records of the International Meteorological Congress of Paris, 1900, "Relation entre quelques mouvementes microseismiques et l'existence, la position et la distance des cyclones a Manille (Philippines), par le R. P. José Algué, S. J., Director de l'Observatoire de Manille."

[2] The detailed description of the apparatus may be seen in the "Bolletino della Societa Seismologica Italiana," Vol. III, pp. 85, etc., and Vol. V, pp. 33, etc.

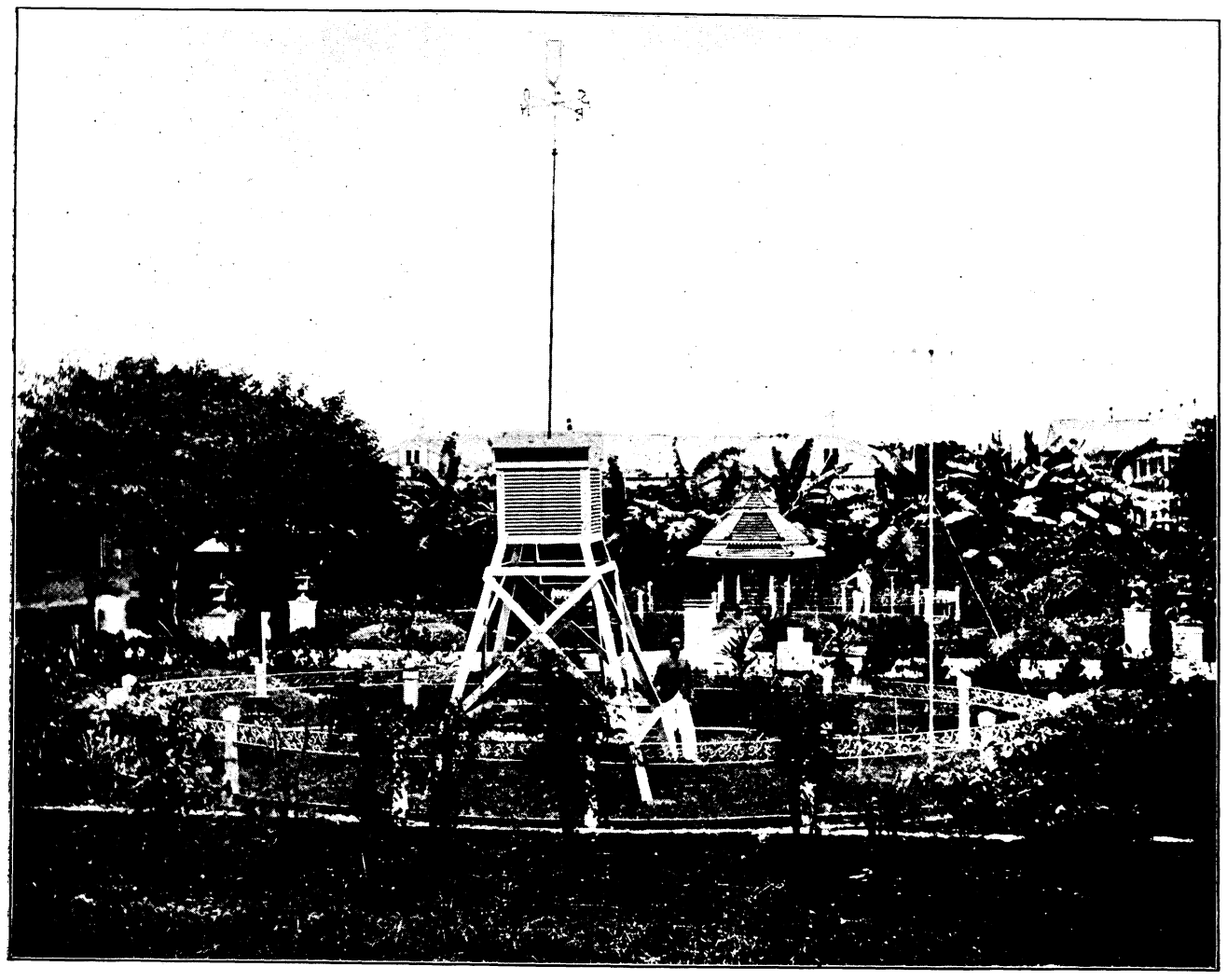

PLATE VI.—GENERAL VIEW OF THE METEOROLOGICAL PARK.

be so regulated by moving it in azimuth that the traces of the pen can be made closer together or wider apart at pleasure. The paper revolves at the rate of 1½ cm. per minute, but this velocity can be doubled. The paper is changed every day. On the same smoked paper a stroke is marked every half minute by means of a needle electrically connected with the pendulum of a good clock. The mechanically marked traces of the Vicentini apparatus has the advantage over the photographic traces of other instruments in that the most minute marks are clearly distinct.

Description of the Meteorological Park.—Having already spoken of the installation of the apparatus located in the tower of the main building, a few words remain to be said about the meteorological park.

In the midst of the gardens two small elevated portions are reserved for the installation of various meteorological apparatus, part of them in the open air, and part in the shade. These two oval spaces are situated symmetrically one on each side of a cement walk which joins in a straight line the astronomical and magnetical buildings, and each one is inclosed by an iron fence, as may be seen in the accompanying Plate VI. The ground is covered with grass, and is somewhat elevated, so that it may not be overflooded with rain during the wet season. In one of these spaces is erected a shelter such as is used in the United States, and within which are placed a set of thermometers and hygrometers similar to those in use in the Secondary Stations of which we shall speak later on. On top of the shelter rises the Wild anemometer. The rest of the space contains the following instruments:

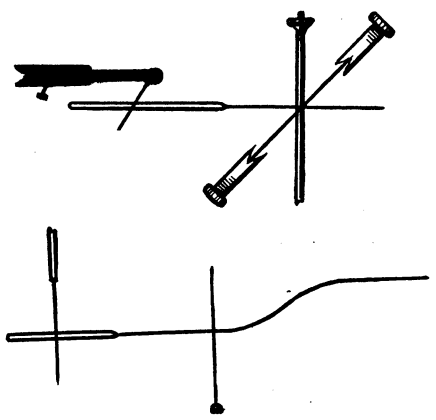

FIG. 4.

A spindle nephoscope.

Various pluviometers.

One Richard pluviograph.

In the center of the second space stands a meteorological pavilion of special construction suited to the climate and latitude of these regions. (Plate VII.)

It is constructed of two distinct roofs, which are supported by six pillars. The upper roof, which is of wood, is of threefold louvre work, so that the air can circulate easily; while the lower is of palm leaves called by the native "nipa." This roof is of such a nature that, besides being almost impenetrable by heat, there is always a current of air passing between the two parts.

With this arrangement, it is easy to see that even in the months of April and August, when the rays of the sun fall perpendicular on Manila the heat falling upon the outer roof can not penetrate through the nipa roof and so can not affect the instruments in the interior of the pavilion.

The instruments are placed fairly high so that they can not be seen from outside the prolongation of the higher roof and consequently there is no danger of any ray of the sun falling upon them. Since, as may be seen from the figure, there are no walls to the pavilion, the air can circulate through it, no matter in what direction the wind is blowing, just as if the instruments were out in the open.

The apparatus which are in continual operation within the pavilion are:

Maximum and minimum thermometer,
A psycrometer,
A psycrograph,
A thermograph,
A vaporimeter,

and very frequently other similar instruments for comparison.

Outside of the shelter on the ground of the second space there are also:

A maximum solar radiation thermometer with a manometer by Negretti and Zambra,
A minimum thermometer for terrestrial radiation,
An actinometer of Arago, and
A new type of self-registering actinometer by Richard.

This last instrument, which has but recently been acquired, consists of two thin, hollow copper spheres 13 cm. in diameter, the exterior surface of one being covered with lampblack, while the other is perfectly polished and gilded. In this the instrument is like that of Violle. The thermometers which receive the calorific effects of the solar rays are metal ones, and consequently unlike the Herschell system. They are composed of copper wire three millimeters thick, which forms a ball spiral in the interior of each sphere. This wire then descends through the two supports of the spheres to a box in which is the registering apparatus. The interior arrangement of this box is the same as that in the compensated thermographs. Two pens moved by levers mark traces on the drum of the clock.

Finally we must mention three complete series of thermometers for taking the temperature underground at different depths.

One series is of the Fuess type at the depths of 0.25, 0.50, and 1.00 meters, respectively.

Another similar series, with wood supports at the depths of 0.35, 0.45, 0.75, and 1.50 meters below the surface.

The third series consists of four Richard thermographs which register the temperatures at the depths of 0.50, 1.00, 1.50, and 2.50 meters.

Meteorological observations and publications since the year 1865.—The series of meteorological observations taken in this central Office from the date of their commencement are as follows: From the year 1865 to 1880 only six observations were made daily; in 1880 were begun the hourly observations during the day, i. e., from 5 o'clock in the morning till 11 at night; and since 1883 hourly observations have been made during the night as well. In the beginning all these observations were made every hour with direct apparatus, but at present, as the Observatory is well provided with very trustworthy self-registering apparatus, the hourly data during the night are taken from these instruments, though during the day, from 5 a. m. to 9 p. m., the observations are made with the direct instruments also. In 1890 these hourly observations began to be published in the monthly Bulletin, and the numerical values of the observations from 1878 were published, together with a study of the meteorological elements of the month, note being made in a special manner of atmospheric disturbances.

All these data, as well as the discussion of the same, the monthly and annual record of the meteorological elements, together with the tables of the observations, form the series of our publications till 1887. In this year the monthly Bulletin was enlarged by the addition of the seismic and magnetical observations. From the year 1890 the monthly Bulletin has been much more complete, for it contains a study of the atmospheric, seismic, and magnetic observations, tables and curves of the hourly meteorological and magnetic observations, and, finally, two daily observations from the stations of the second and third order.

The above is what we may call the ordinary publications, but besides this we have printed from time to time, a large number of extraordinary publications dealing principally with the typhoons of the Far East. The reader may see a detailed list of these works of the Manila Observatory in Appendix G.

Comparison of instruments.—We may mention here, in passing, another of the services which the Observatory renders to the general public, namely, the comparison of instruments. The public, and especially mariners, know that they may bring to the Observatory, at any time, all kinds of barometers and barographs or other meteorological instruments, with the assurance that they will be carefully compared gratis with the standard ones in the Observatory. Here these instruments are tested, their working observed, and, if it is thought necessary, a report is given of the instrumental error of the apparatus.

Another similar work which the astronomical department undertakes daily is the rating of the chronometers which the mariners in the harbor frequently bring to the Observatory for that purpose. This is also done gratis. The number of chronometers annually rated is about a hundred.

The ordinary weather notices.—The Observatory receives daily by cable meteorological data from the coasts of China and Japan. These data are carefully discussed in conjunction with those received from the stations distributed throughout the Archipelago, and a notice is then made out

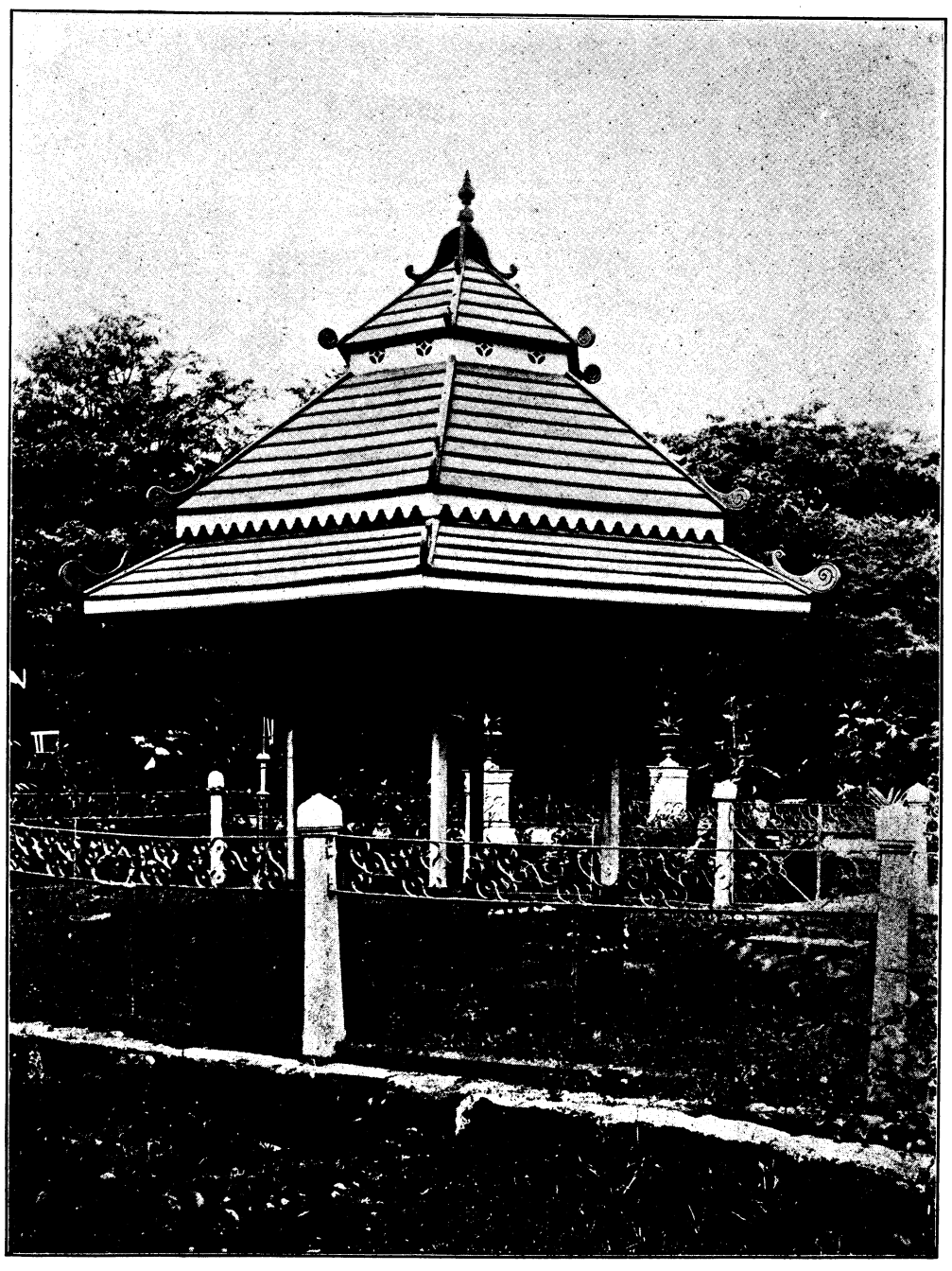

PLATE VII.—THE SPECIAL PAVILION FOR TROPICAL REGIONS.

concerning the probable weather of the next twenty-four hours. This notice is published in the periodicals of the city and transmitted by telegraph to the Hydrographic Office, to the Captain of the Port of Manila, to the commanders of the squadron and of the naval station at Cavite, and finally to all the principal stations in the Archipelago, where it is made known to the public. Besides this the maximum and minimum temperature of every day are sent to the periodicals of the capital and at 8 a. m., 10 a. m., and 4 p. m. the observations made in the Observatory of the atmospheric pressure, temperature, direction and force of the wind, and state of the weather are sent to the above-named officials. These same observations are sent to the Hydrographic Office and to the Captain of the Port, four times a day, namely, 8 a. m., 10 a. m., 12 noon, and at 4 p. m. In the telegram sent at noon is also added whether or not the fall of the time ball was exact,[1] the letters O K being added if it fell on time, and the error given in the contrary case.

Typhoon warnings.—When there is any atmospheric disturbance in close proximity to the Archipelago the work and vigilance of the directors of the Observatory are redoubled. At the first signs of the baguio, the observations are taken more frequently than usual, specially those of the direction of the different classes of clouds, and if it is thought necessary the observations are asked for, hour by hour, from those secondary stations which may most feel the influence of the baguio. The public of Manila, the Captain of the Port, and the authorities are then advised of the existence of the storm, as well as those who ask for information at the Observatory. As soon as the situation tion of the baguio and the approximate direction it is likely to take are known, the Captain of the Port is advised to hoist the proper signal.

If the baguio is not near, or dangerous for the capital, the Observatory simply gives the course of the storm in the weather notices, which it sends to the authorities and to the Captain of the Port; though it transmits full information to those provinces of Luzon which are the most threatened, that they may prepare for the coming of the storm. If, on the contrary, the baguio threatens to be dangerous for the locality, then the number of observations is still further increased, even during the night, and more or less urgent warnings are given to the authorities, according as the case requires. A more detailed account of the danger is given to the commanders of the fleet and to the Captain of the Port; in a word, all the means and precautions are taken which are best suited to avoid any accidents, as far as it is possible.

The Observatory not only pays these attentions to the public at large and to the authorities of Manila, but is also accustomed to warn those shipping houses, who have announced the sailing of any vessel, in order that they may postpone the day of sailing if that be necessary, or in case the vessel does leave port, that the captain may be forewarned of the danger and may thus take measures to escape it.

Relations of the Observatory of Manila with other meteorological centers of the Far East.—The attention of the Observatory and the services which it renders are not limited to Manila, or even to the Philippine Archipelago, but are extended to the other meteorolgical centers in the Far East. Some of these services are ordinary, which consist of daily cablegrams, and others are extraordinary, or typhoon warnings.

The meteorological observations which are sent twice daily to stations outside the Philippines are those taken at 10 a. m. and 4 p. m. They are expressed, for example, in the following form:

761 = Barometer corrected for everything except gravity.
NE = Direction of the wind.
4 = Force of the wind, scale 0–12.
29 = Thermometer in the shade.
B = State of the weather.
3 = Amount of rainfall since the last telegram.

[1]The time ball falls at 0^h of meridian 120° east of Greenwich, which is situated 3^m 52.2^s West of the meridian hitherto employed.

The following are the stations outside the Archipelago with which we exchange observations twice a day:

Station.	Latitude north.		Longitude east of Greenwich.	
Japan.	°	′	°	′
Nemuro	43	20	145	35
Hakodate	41	46	140	44
Tokio	35	41	139	45
Kochi	33	33	133	32
Nagasaki	32	44	129	52
Kagosima	31	35	130	33
Oshima	28	23	129	30
Naha	26	13	127	41
Ishigakijima	24	20	124	07
Formosa.				
Taihoku	25	04	121	28
Taichu	24	02	120	40
Hokoto	23	33	119	34
Tainan	22	59	120	12
Taito	22	45	121	08
Koshun	22	04	120	47
China.				
Shanghai	31	12	121	20
Amoy	24	40	118	00
Hongkong	22	16	114	09
Indo-China.				
Haiphong	20	52	106	40
Tourane	16	07	108	13
Nhatrang	12	16	109	12
Padaran	11	35	109	09
Cape St. James	10	20	107	05

The correspondence with the station of Taihoku, Formosa, is special. In a communication, dated the 15th of January, 1902, which the Director of Taihoku sent to the Director of the Manila Observatory, it was asked that from the 15th of February of the same year, the observations of Aparri and Legaspi might be sent to him with those of Manila, as soon as the stations in the two extreme points of the Island of Luzon were established. He offered in return to coöperate with the work of the meteorological service by sending the observations taken at 5 a. m. and 1 p. m. of meridian 120° in Taihoku, Taito and Koshun, stations in the Island of Formosa, and those taken at Hokoto in the Marshall Islands. In consequence of this and owing in great part to the cable companies,[1] who offered to transmit the observations gratis, we now send daily to the chief of the Observatory of Taihoku, at 6 a. m. and 2 p. m., the reading of the barometer in three figures, the direction and force of the wind in two, the temperature in two and the state of the weather in one letter.

Later on the Director of the recently established meteorological service of Indo-China sent a communication to the Director of the Observatory of Manila, dated the 2d of May, 1902, in which he offered to send daily by cable the observations taken at 10 a. m. and 4 p. m. at the central station of Haiphong and at the stations of Cape St. James, Padaran, and Tourane.

These cablegrams are sent in cipher according to the code of the Observatory of Zi-ka-wei.

The observations which come from the stations of Indo-China are composed of two groups of five figures (for example, 59222, 43274), which read as follows: The first three contain the reading of the barometer, corrected for temperature but not for sea level; the two following, the direction of the wind, 32 directions being reckoned. In the second group the first figure represents the force of the wind according to the scale 0–9, the second the state of the sky, according to the scale 0–9, the next two figures give the temperature in the Centigrade system, and, finally, the last expresses the

[1] The companies we allude to as having so assisted the meteorological service of the whole of the Far East are those we have mentioned in another place, namely, the Great Northern Telegraph Company and the Eastern Extension Australasia and China Company.

state of the sea, using a scale of 0–9. It will not be out of place here to add the form in which the other meteorological stations of the coasts of China and Japan send their daily observations and thus give a complete idea of the telegraphic service we have in relation with other observatories.

The other stations on the coast of China send their observations in the same form as our Observatory, with the exception of using inches and the Fahrenheit scale instead of the decimal system.

The cablegrams from the Japan stations consist of a group of four figures, for example: 6513, of which the two first give the reading of the barometer reduced to sea-level and corrected for temperature and gravity, the standard value adopted being that of latitude45°; the third figure represents the direction of the wind, only 8 points of the compass being taken into account, of which NE is is represented by 1, E. by 2, and so on; the fourth figure gives the force of the wind, the scale being 0–6. These cablegrams are received twice daily, namely, 6 a. m. and 2 p. m. mean time of meridian 135° east of Greenwich.

The observations from Taihoku and the other stations of Formosa, which is an extraordinary service, are sent in a group of seven numbers, of which the first three give the reading of the barometer corrected for gravity, the next two the direction and force of the wind in the scale of 0–8 and 0–6, respectively. Then comes the temperature in two figures and the state of the weather by a special letter, thus: 6913121 B. These observations from Formosa are sent twice daily, at 5 a. m. and 1 p. m., of meridian 120° east of Greenwich.

As the reader has just seen, it is scarcely possible to have a greater variety of observations which the stations of the Far East communicate to us daily both as to number and form, as well as to the correction employed and the scales and gradations adopted. There is no doubt that complete uniformity in what regards the telegraphic service between the stations of the Far East would increase the utility of such observations, and it is hoped that before long such a uniformity, which several of the directors of the different scientific centers have tried to bring about, will be adopted.

Besides the ordinary observations which we have just mentioned, the Observatory of Manila also sends out by means of telegrams notice of the existence and probable course of the typhoons which, having their origin in the Pacific, are first felt in the Philippine Archipelago. These warnings are ordinarily sent to the capitals of the coast of China and Japan, namely Hongkong, Macao, Saigon, Haiphong, Shanghai, and Tokio.

These telegrams are usually three for each typhoon, one when the first symptoms are noted, announcing its existence and position; another when it passes at the minimum distance from the Archipelago, or crosses the islands, already indicating not only the position but, if possible, the direction of the meteor; and another final one when it leaves the Archipelago, either by the China Sea or by the Pacific, in the direction of Japan. The eagerness with which these telegrams are received in the neighboring colony of Hongkong is known to all who reside there. Besides this, telegrams are often received from captains of ships anchored in the different ports of the Archipelago and even in Singapore and Hongkong, asking the opinion of the Observatory in regard to the weather, as to whether or not there is danger of encountering a typhoon in the passage from these ports to Manila. These telegrams the Observatory of Manila always answers as promptly and as definitely as possible.

Beyond this, there is no reason why we should praise here the services rendered by this Observatory to mariners and merchants and to the general public by the announcements of storms which it issues to Hongkong, Macao, Saigon, Shanghai, and Tokio. The position occupied by the Manila Observatory makes it a kind of outpost whence the coasts of Asia and Japan can be warned in due time of the existence and march of the typhoons. Innumerable examples could be adduced in confirmation of this, but such a course is unnecessary.

The storms which, passing through our latitudes more or less near to Manila, cross the China Sea, do not generally reach the Asiatic coast for two or three days and even longer, as the experience of many years teaches us; and those which we feel in the eastern part of Luzon, and which travel in the direction of Japan, take from three to ten days, and even longer, in crossing. This clearly manifests the utility of our observations and storm warnings to the continent of Asia, the Empire of Japan, and to all foreigners who navigate these seas. This the governments of the colonies of Hongking, Saigon, Macao and Shanghai, understood when they asked for telegraphic advices of typhoons from the Observatory of Manila.

MAP SHOWING THE FOREIGN STATIONS IN TELEGRAPHIC CONNECTION WITH THE MANILA OBSERVATORY.

In map No. 1 may be seen the meteorological centers of the Far East which are in telegraphic connection with our Observatory. We have already given the catalogue of these stations together with their coördinates of latitude and longitude. We have also specially marked the foreign stations which regularly receive our typhoon warnings.

In the same map three other stations have been noted as "wanted stations," namely: Yap (West Carolines), 9° 29′ latitude north, 138° 05′ longitude east of Greenwich; Guam (Marianas Islands), 13° 28′ latitude north, 144° 44′ longitude; and Ponapé (East Carolines), 5° 46′ latitude north, 158° 23′ longitude east, stations of great importance, which will be included in the telegraphic service as soon as they are united to Manila by cable.

Many other stations send us their observations weekly or monthly, and these observations are very useful as helping to a better knowledge of typhoons. These stations are not included in the present map, as we limit it to the telegraphic and official service.

VI. OFFICIAL APPROVAL OF THE METEOROLOGICAL SERVICE BY THE GOVERNMENT OF THE UNITED STATES.

Preliminary notes.—The ordinary daily meteorological services which we have just mentioned in the preceding paragraph, as well as special notices when any atmospheric disturbance occurred, were kept up without interruption by the Observatory during the whole course of the war, even on the most dangerous days.[1] This is the more to be taken into account when it is remembered that the Observatory is situated outside the walls, and faces that part where most of the conflicts took place.

The American authorities soon came to appreciate the value of these services, and from the very beginning held them in great esteem. The first who gave token of his appreciation was the Admiral, Mr. George Dewey, who was stationed for several months in succession in Manila Bay, from May 1, 1898. He, as well as the other commanders of the fleet who were then present assisting in the grave events which were developing in the capital of the Archipelago, received the different typhoon warnings and notices. The Admiral several times sent his congratulations to the Observatory in return for communications with regard to atmospheric changes. There is a letter which the Secretary of the flagship Olympia sent to Rev. J. Algué, dated November 2, 1898:

FLAGSHIP OLYMPIA, *Cavite, November 2, 1898.*

DEAR SIR: Rear-Admiral Dewey desires me to again thank you for your courtesy in giving him such complete information concerning your typhoon predictions, which he has in every case found to be correct.

Faithfully, yours,

H. H. CALDWELL, *Flag Secretary.*

Rev. J. ALGUÉ, *Director Manila Observatory, Manila.*

Leaving aside other documents of the same nature, we will bring forward two facts in confirmation of what we have said. The first is the communication which a high official of the English fleet at Hongkong made to Admiral Dewey shortly after the cable which joins Manila and Hongkong was broken. In it he asks that the connection should be reëstablished, if he did not wish to be responsible for the loss of life and property, *which would undoubtedly* result from the lack of the telegraphic advices of typhoons from the Observatory of Manila.

The second fact alluded to is the petition which Colonel Thompson, chief of the telegraphic corps, made to the Observatory, on behalf of Mr. Ronsevelle Wildman, consul-general of the United States in Hongkong, in which it was asked that, as soon as telegraphic communication was reëstablished, our telegrams should be sent directly to him, as they had formerly been sent to the Spanish consul, when Manila was under the Spanish flag.

But what contributed most of all to make our work known to the new Government was the famous question of Mr. W. Doberck, which, as we have said, coincided with the change of sovereignty of these Islands. In order to show what the Americans thought of this controversy and

[1] See the Bulletins for 1898 and 1899 and the periodicals of the capital for August, 1898, and February, 1899.

FOREIGN METEOROLOGICAL STATIONS IN TELEGRAPHIC CONNEXION WITH MANILA CENTRAL OBSERVATORY 1902

SIGNS

- Manila Central Station
- Foreign Meteorological Stations
- Chief towns warned
- Wanted Stations

CHINA SEA

JAPAN

KOREA

PHILIPPINE ISLANDS

INDO-CHINA

TONGKING

FRENCH COCHINCHINA

ANNAM

LUZON

MINDANAO

BORNEO

LIUKIU Is

LINSCHOTEN Is

BONIN Is

ARZOBISPO or BONIN Is

BABUYANES Is

BATANES Is

PELEW Is

WESTERN CAROLINAS Is

EASTERN CAROLINAS Is

Nemuro
Hakodate
Tokio
Nagasaki
Kagoshima
Shanghay
Yehshima
Yaha
Taihoku
Ishigakijima
Amoy
Taichu
Hoko
Tainan
Tamsui
Makung
Hongkong
Haiphong
Tourane
Nhatrang
Saigon
Cape St. James
Manila
Guam
Yap
Ponape

Longitude E of Greenwich

consequently of the Observatory, it will not be uninteresting to quote an article of the well-known meteorologist, Mr. Everett Hayden, written after his arrival in these Islands. He says: "I beg to submit the following for publication, inasmuch as serious injustice seems to have been done, however unintentionally, to the Manila Observatory, well known for many years for its excellent work in meteorology, in seismology, magnetism, and time service.

"The unfortunate controversy with Dr. Doberck, of the observatory at Hongkong, was finally settled in April last, when the United States Military Governor of the Philippines sent a letter to the Director of Manila Observatory revoking the order of the preceding February, and allowing the transmission of typhoon warnings from Manila to the east coast of China and Japan, as usual. This letter inclosed to Rev. P. Algué a copy of a letter from the colonial government at Hongkong disavowing Dr. Doberck's action and suggesting a continuance of the cablegrams, a result of the immediate and practically unanimous protest by the Chamber of Commerce, newspapers, and shipping interests generally all along the coasts.

"In view of this unanimous request for a continuation of the so-called 'sensational typhoon warnings,' the fact that Padre Algué has all the telegraphic data available at Hongkong, if not more, and he is some 600 miles nearer the scene where these typhoons usually first make their appearance, the value of his predictions for commerce is self-evident.

"It may be added, further, that the Manila Observatory has made and is making no effort to force its warnings upon the public, nor does it derive any revenue therefrom, nor is its support a cause of any expense whatever to the Government or the public who utilize its services, to justify the attempt to suppress such praiseworthy efforts on the ground that *'the United States and Canadian meteorological services never presume to issue forecasts, storm warnings, from any part of the territory under sovereignty of the other,'* is surely a mistake, for the reason that these typhoon warnings are primarily for the benefit of commerce on the high seas, representing, yearly, very many thousands of lives and probably hundreds of millions of dollars (especially if we include, as we ought, the many strong naval fleets in these waters). Imagine a group of islands extending from Bermuda to Haiti, and a well-equipped observatory at Bermuda, with an organized and experienced staff; our Government could not and would not object to the publication in all our coast cities of the fact cabled from Bermuda that a hurricane was central in such and such a position and moving along a certain course at a certain estimated speed. For my part, I would value such information far more highly in the words of the cablegram than as modified and possibly weakened by the forecasting official at Washington, burdened as he is with predictions for a great nation and an enormous area, all to be made within a few brief minutes. To complete the parallel, the observer at Bermuda would have before him absolutely all the data available in Washington, as well as the sky and area, 600 miles nearer the storm conditions, impossible adequately to portray to another in a brief cablegram, but vital to the subject.

"The position of the eminent Director of the Manila Observatory in this controversy, acting, as he has done, solely upon the defensive, has been scientifically and honorably maintained."

Thus the above-named author expressed himself on the 19th of August, 1899. We could quote many other documents, all of them of great weight, written by the commanders of the squadron who succeeded Admiral Dewey, as well as those who had the charge of the Captaincy of the Port of Manila, showing the position in which the Observatory was placed on different occasions before the American authorities in the Philippines. For the sake of brevity we will limit ourselves to what we have already said.

Relations of the Observatory with the new authorities.—The meteorological service, as regards the central station, suffered no interruption, in spite of the grave events of the Philippine insurrection and the Spanish-American war; and we may add that neither did any interruption take place on the entrance and possession of the Islands by the American Government. As a matter of fact, the Spanish Government had, for obvious reasons, decided that the ordinary storm signal should not be hoisted during the blockade, but as soon as the new Government had taken possession of Manila Mr. McMillan, lieutenant of marines, who had charge of the Captaincy of the Port as regarded hydrography and meteorology, put himself in communication with the Observatory concerning what

was of most importance, seeing that it was the typhoon season, namely, the placing of the typhoon signals in the port, as before. He then took upon himself the work of repairing the signals and raising them properly, conformably to the warnings sent out by the Observatory.

These warnings could not be communicated very rapidly at that time, or be sent to the more distant ports of the Archipelago, owing to the want of personnel and the permanent telegraphic isolation of the Observatory. Almost two months went by, without this service, but every day its want was felt more and more, on account of the number of storms which rapidly succeeded one another. On October 4, 1898, the United States Signal Corps restored our station, which was one of the first to form part of the new line in direct communication with the cable.[1] From that time on, cablegrams were received daily from the ports of Iloilo and Cebu, thanks to the invaluable observations which the captains of those ports made. For a long time these were the only observations received by the Observatory from the Archipelago. These reports were sent with the greater faithfulness, because the said captains felt it greatly, that the ordinary weather notices which were published in Manila were not sent to them, especially as they were repeatedly asked for during the storms which occurred from the 2d to the 8th of July, 1899.

Besides what has already been said, a new service, hitherto not contemplated, was established about this time. The service is of great value in many ways, and is now in general use in the whole of the Archipelago. This was the automatic transmission of the time from the standard clock of the astronomical department to all the telegraphic stations of the Philippines. The occasions which gave rise to this arrangement were two: The first was the communication which the captain of the port of Iloilo made to us, on August 31, through the Captain of the Port of Manila, inquiring as to the transmission of the official time from the Observatory and the expense this transmission would cause, the second and principal one was the definite order of the Government of Washington concerning the official time to be adopted by the whole of the Archipelago, which was to be that of the meridian 120° east of Greenwich.[2] This order was communicated to the Observatory by Colonel Thompson, on the 4th of September, 1899, and, under the new arrangement, the time ball fell for the first time at midday of the 6th of the same month.

The Chief of the Signal Corps thought it advisable that the advantage of having the exact official hour should be extended as soon as possible to the other official centers, and on the same day, the 6th, his order came for Captain Russell of the same Corps to make the proper arrangements. The following day the employees of the Corps laid the proper lines from the astronomical department to the telegraphic apparatus so that they could be switched on at pleasure, and on the 9th, at 11 a. m. the transmission of the official mean time to all the stations which were then in telegraphic connection was begun; four days later it was also sent by cable, so that the request of the captain of the port of Iloilo was complied with.

From what has been said, it is clear that even when the sovereignty of these Islands was handed over to the United States of America the work of the Observatory did not change in the least, and to this work the new authorities corresponded with all the generosity that could be desired. As a matter of fact, the Military Governor first sought information from the Directors of the Observatory and then through the lieutenant of the Engineering Corps, Mr. Connor, W. D.

The latter, replying to the letter of the Provost of Manila, dated March 7, 1899, presented documents on the 22d of the same month, which gave full information on the matter.[3] This was so satisfactory that the Miltary Governor, Maj. Gen. E. Otis, not only continued to honor this Observatory with the same good will which it had won under the old Government, but confirmed it in the

[1] It was necessary to lay new lines because the old ones were either interrupted or in the hands of the insurgents.

[2] Previous to the above order some correspondence had taken place between the Government of Washington and the Governor of the Philippines, E. Otis, and between the latter and the Director of the Observatory. There was some difficulty in adopting the one hundred and twentieth meridian, because it falls almost outside the archipelago. To obviate this difficulty Fr. José Algué proposed the one hundred and twenty-first, which traverses the middle of Manila, but the first was decided upon which thus gives a difference of exactly 8^h with respect to Greenwich. The meridian of the astronomical department is $8^h\ 3^m\ 54.2^s$ east of Greenwich.

[3] This information, which is of great interest, can be seen in Appendix A.

official character it had enjoyed since 1884. Furthermore he favored the Observatory with the same assistance which Spain had conceded to it, till May of 1901, when the new law, of which we shall speak presently, was decreed.

New publications.—To satisfy the frequent demand which the chiefs of the different official centers and other persons of authority in the Islands, had made to the Observatory for meteorological data, and especially on account of the attention which was due to the new Government, which already supported this institution, it was deemed fitting to start a new series of publications in harmony with the conditions of the Archipelago.

In March, 1899, the first number of a new monthly publication having the title of "Climatological Data for Manila" was sent out. In the beginning it contained only the more interesting meteorological data of the month, with a discussion of the same, and of the storms that had occurred during the month. At the commencement of 1901 a résumé of the magnetical observations was added, and at present, besides the crop services of which we shall speak later, seismical notes are also published in it, as well as astronomical observations of any special interest.

Among other pamphlets published about this time there was one which contained a résumé of the climatological data concerning Manila, entitled "Interesting Climatological Data concerning the Weather of Manila, compiled by the Manila Observatory."

New official declaration of the Philippine Meteorological Service.—The official declaration of the Meteorological Service of the Archipelago by law could not be made till the Government of Washington had been first consulted. For this a good opportunity offered itself.

Several members of the first United States Commission in the Philippines, especially the President, J. G. Schurman, and Prof. Dean C. Worcester, honored the Observatory with their visits. During these visits they had the opportunity of seeing the means at the disposal of the Observatory, and at the same time of treating with the Director, Fr. J. Algué, whom they had already consulted. They thought it good that an atlas of the Archipelago should be made, as well as a collection of general information which should contain as much data as possible as to the riches and civilization of the Islands.

It was decided that the atlas, together with the voluminous information on hand, to which several Fathers of the Mission of the Society of Jesus had contributed, should be published by the Government press. That all care might be taken in correcting the edition, the above-named Fr. J. Algué was called to Washington by the Secretary of War by a cablegram of December 10, 1899.

Fr. J. Algué, accompanied by Fr. J. Clos, started for the capital of the United States on the 28th of the same month, taking with him the reports which he had just prepared at the instance of the Commission.

Fr. Doyle, an Irishman, who had had many occasions to treat with the American authorities during the past months, was named Director for the time being.

The Meteorological Service of the United States compares with the best in the world in its organization and the extent of its operations. Willis L. Moore, the Chief of this Service, who, from his first interview with Fr. Algué, showed a keen interest in the reorganization of the Philippine Meteorological Service, thought the Philippine service should be improved and modeled on that of the United States.

Prof. Dean C. Worcester, who had already been nominated a member of the second Philippine Commission, was present at the first meeting.

Mr. W. Moore introduced Professor Worcester and Fr. Algué to the Secretary of Agriculture, to whom the Chief of the Meteorological Service of the United States proposed the plan of establishing in the Philippines a Meteorological Service independent from that of the United States and of placing Fr. Algué at the head of it. He added that the Meteorological Office of Washington would assist in its erection and give all the help possible. Mr. Wilson, the Secretary of Agriculture, approved of the plan.

For some time after this the above-named chief and Fr. Algué were arranging the basis of the new service, and in conformity to this, Fr. Algué prepared the information he had to present to the Civil Commission. Mr. Willis L. Moore first examined the information and approved of it, on

March 26, 1900, and toward the end of the same month it was presented to the Commission. The Commission decided that Prof. Worcester should take a copy of the information with him in order that the Civil Government, which was to be represented in the person of Mr. W. Taft, the then President of the second Commission, might enact the law of reorganization of the said Meteorological Service of the Philippines.

Fr. J. Algué, who had been already officially named Director of the Meteorological Service, was authorized to buy in Europe the apparatus for the secondary stations, for which an appropriation of money had been made. Moreover, Professor Moore showed his good will to the Director by offering to procure for him all the apparatus that could be bought in the United States, and sending them on already compared and corrected under the direction of the same Central Office in Washington. Thus all difficulties were overcome, and the road prepared for the desired official establishment.

As to the dependence which the Director of the Philippine Meteorological Service was to have on the Government in the exercise of his charge, it was resolved that he should be subject to the Colonial Government in the same way as the Chief of the Meteorological Service of the United States was to the Secretary of Agriculture.

The second Philippine Commission received from the President of the United States legislative power in virtue of which it enacted laws when it was established in the Philippines with its civil character. Among the laws thus enacted, in May, 1901, was the one concerning the Philippine Meteorological Service.

While the printing of the report and the above-mentioned atlas was nearing completion, in the correction of which works Fr. Clos also had been engaged, Fr. Algué went to Europe, where he obtained the apparatus necessary for the equipment of the stations and, as was said in Paragraph IV, represented the Philippine Government at the Paris Exhibition, returning to the United States toward the end of the year. Their task being thus successfully ended, the two Jesuits left America via San Francisco, arriving in Manila on the 28th of January, 1901.[1]

As soon as the many labors of the Colonial Government permitted, the work of reorganizing the Meteorological Service on the lines laid down in Washington was taken in hand. The work of drafting the law was given to Prof. Worcester who, when he had finally overcome all difficulties, laid it before the Commission. After it had been discussed it was passed on to the printers whence it was given over to the discussion and approval of the public.

In the public session, which opened at 10.30 of the 22d of May, Prof. Worcester read the projected law, adding a few words on the great utility of a good Meteorological Service for the whole Archipelago. After the bill had been read, and no difficulty raised concerning it, it was unanimously approved, and from that time has remained in full vigor.

This law contains 16 sections of the following tenor:

SECTION 1. A Weather Bureau is hereby established for the Philippine Islands. It shall be known as the Philippine Weather Bureau.

SEC. 2. The officers of this Bureau shall be a Director at an annual salary of two thousand five hundred dollars; three assistant directors, at an annual salary of one thousand eight hundred dollars each; and one corresponding secretary and librarian, at an annual salary of one thousand four hundred dollars. They shall be appointed by the Commission.

SEC. 3. The employees of the Weather Bureau shall be:

(*a*) For the central station: Three first-class observers, at an annual salary of nine hundred dollars each; three calculators, at an annual salary of seven hundred and twenty dollars each; two assistant observers and an assistant librarian, at an annual salary of six hundred dollars each; two assistant calculators, at an annual salary of three hundred dollars each; one first-class draftsman, at an annual salary of seven hundred and twenty dollars; one second-class draftsman, at an annual salary of six hundred dollars; one first-class mechanic, at an annual salary of seven hundred and twenty dollars; three assistant mechanics at annual salaries of six hundred dollars, four hundred and twenty dollars, and three hundred dollars, respectively; two janitors, at an annual salary of one hundred and fifty dollars each; and two messengers, at an annual salary of one hundred and fifty dollars each.

[1] The Chief of the United States Board on Geographic Names had intrusted to the two above-named Jesuits, during their stay in Washington, the revision and correction of the official list of geographic names of the Philippine Islands, published in the Special Report of the United States Board on Geographic Names, relating to the geographic names in the Philippine Islands.

(*b*) For the branch stations: Nine chief observers for first-class stations, at an annual salary of six hundred dollars each; nine assistant observers for first-class stations, at an annual salary of one hundred dollars each; twenty-five observers for second-class stations at an annual salary of three hundred dollars each; seventeen observers for third-class stations, at an annual salary of one hundred and eighty dollars each; twenty observers for rain stations, at an annual salary of ninety dollars each.

(*c*) All employees of the Weather Bureau shall be appointed by the Director, subject to the provisions of the Civil Service Act and of Act Twenty-five.[1]

SEC. 4. The Director shall have general supervision and control over the work of the Bureau, and shall define the duties of the assistant directors, of the corresponding secretary and librarian and of all employees. He shall maintain an efficient system of weather forecasts and storm warnings, if any, to the captains of all ports in the archipelago which are in telegraphic communication with the capital, to the chief executive of the Insular Government, to the Commission, to the heads of all Civil Departments and Bureaus in Manila, to the commandant of the naval station at Cavite, and to the public press of Manila, Cebu, and Iloilo. When dangerous storms threaten any portion of the archipelago, he shall send telegraphic warnings to the threatened district, if practicable. Forecasts and storm warnings shall be sent to all branch stations in telegraphic communication with the central station, and there posted for the benefit of the public. Warnings of dangerous storms likely to strike the Asiatic coast, Formosa, or Japan shall, if practicable, be communicated by telegraph to the directors of meteorological observatories situated within the threatened areas or to such persons as may be officially designated by other governments to receive them. The Director shall further cause to be prepared a monthly bulletin and a monthly report. The monthly bulletin shall contain a brief résumé of the chief meteorological phenomena of the preceding month and a comparison between the phenomena observed and the normal conditions for the month in question, as well as a résumé of the crop reports received from the branch stations. Five hundred copies of this bulletin in English and five hundred in Spanish shall be published by the Director for free public distribution.[2] The monthly report shall contain the observations made at the central stations and the branch stations, together with such discussions of them as the director may deem profitable, also crop reports from the several stations. Five hundred copies shall be printed. It shall be published in the Spanish language until January first, nineteen hundred and two, and thereafter in the English language. The bulletin and report shall be published by the Manila Observatory, but the Insular Government shall pay the actual cost of paper, typesetting, presswork, and binding. The Director shall further cause such special reports and maps to be prepared from time to time as the Commission may authorize or direct. When it is deemed desirable to publish special reports or maps, the number of copies to be printed and the methods of publication shall, in each case, be fixed by the Commission.

SEC. 5. The central station of the Bureau shall be the Manila Observatory. A monthly expenditure of three hundred and seventy-five dollars, in money of the United States, is hereby authorized for the rental of the instruments, instrument rooms, and towers, offices, library, printing room, lithographing room, and printing press of the Manila Observatory, for the type necessary to print the monthly bulletins and reports, which shall be furnished by the Director, and for the maintenance of instruments.[3]

SEC. 6. There shall be, besides the central station, nine first-class stations, twenty-five second-class stations, seventeen third-class stations, and twenty rain stations.[4]

SEC. 7. At the central station hourly meteorological observations shall be made, and a continuous record of meteorological phenomena shall be kept. Weather forecasts and storm warnings shall be prepared and sent out as hereinbefore prescribed, and all reports shall be prepared for publication. Such other meteorological work shall be performed as the Director may require.

SEC. 8. At all first-class stations, hourly meteorological records shall be kept compiled, and they shall be forwarded to the central station by mail at regular intervals, to be prescribed by the Director, together with monthly reports as to the state of the crops in the vicinity. Such daily telegraphic reports of the state of the weather shall be forwarded to the central station as the Director may require.

SEC. 9. At all second-class stations six daily meteorological observations shall be made at times to be speci-

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[1] This law of the Civil Service, the fifth in the series of published laws, is entitled "An Act for the establishment and maintenance of an efficient and honest civil service in the Philippine Islands."

The Twenty-fifth has for title, "An Act providing for the appointment and removal of subordinate officers and employees in certain Departments and Bureaus of the Government of the Philippine Islands."

[2] This monthly pamphlet is the "Bulletin" which is published at the beginning of every month in the two languages. English and Spanish. To supply the demand the number of 500 copies had to be increased.

[3] The reason for building the edifice in which the Observatory of Manila is installed and how it was equipped with the best instruments by the Fathers of the Society of Jesus may be seen in Paragraphs II and III.

[4] In the text of the law are specified the places chosen in each province for the erection of stations. We give the catalogue of those stations further on and omit it here because a few of the places have since been changed in accordance with the tenor of the words with which the sixth section is terminated: "That if, as the work of establishing stations progresses, the Director shall find that in some instance places other than those named in this section are better suited to the requirements of the weather service, he is authorized to change the location of second-class stations, third-class stations or rain stations, in his discretion."

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fied by the Director, and the results for each month shall be compiled and forwarded to the central station before the end of the next succeeding month. Such daily telegraphic reports of the state of the weather shall be forwarded to the central station as the Director may require. Monthly crop reports shall be forwarded to the central station by mail.

SEC. 10. At all third-class stations two daily meteorological observations shall be made, at hours to be fixed by the Director. They shall be forwarded to Manila by wire, if possible, otherwise by mail. Monthly crop reports shall be forwarded by mail.

SEC. 11. At all rain stations there shall be recorded the daily maximum and minimum temperature, barometric readings at six antemeridian and two postmeridian, and daily rainfall. Reports from rain stations shall be forwarded by mail to the central station, together with monthly crop reports.

SEC. 12. Officers or employees of the Bureau employed in the establishment of stations shall be allowed their actual and necessary traveling expenses and the actual cost of transportation of instruments, apparatus and shelters for the same. The nine first-class stations shall be established by the Director immediately, and the other stations authorized in section six as soon as practicable. Employees for the several stations shall be appointed as they are established.

SEC. 13. The officers and employees of the Weather Bureau shall make such observations and reports on astronomical, magnetic and seismic phenomena as the Director may prescribe. The results of such observations may be included in the monthly reports when their publication is deemed desirable by the Director.

SEC. 14. The Director shall cause standard time to be furnished to the city of Manila at noon daily, and to all branch stations in telegraphic communication with the central station, at eleven antemeridian daily. He shall further provide for the free rating of all chronometers brought to the Manila Observatory for this purpose.

SEC. 15. The following sums in money of the United States are hereby appropriated for the purposes named:

(*a*) For the purchase of additional instruments and apparatus for the equipment of nine first-class stations, and for suitable shelters for the same, one thousand seven hundred and eighty dollars and fifty cents.

(*b*) For the erection of shelters and the installation of instruments for nine first-class stations, five hundred dollars.

(*c*) For the purchase of instruments and apparatus sufficient to equip twenty-five second-class stations, for shelters for the same and for cost of installation, four thousand two hundred and fifty dollars.

(*d*) For the purchase of instruments and apparatus sufficient to equip seventeen third-class stations, and for the installation of the same, one thousand and eighty-eight dollars.

(*e*) For the purchase of instruments and apparatus sufficient to equip twenty rain stations, five hundred and twenty dollars.

SEC. 16. This Act shall take effect on its passage.

Enacted, May 22, 1901.

Comparing all that is comprehended in this law, with the services before described, which the Observatory had lent not only to the Archipelago but also to the ports of the coasts and neighboring kingdoms during many years, it will be seen that scarcely anything has been altered both as regards the amount and order of work done in this center.

There only remains to add that there is in this Central Office a mechanical department fully equipped for the work of repairing and keeping in good order the instruments of the Obsevatory and of all the stations of the Philippines.

We will speak later of the reorganization of the Meteorological Service for the whole of the Philippine Archipelago in conformity to the prescriptions stated in the sections of the law.

It is to be noted that, when Judge Taft was named Civil Governor of the Philippines on July 4 and later on in September, and the Civil Government was divided into different parts, the Meteorological Office of the Philippines was placed under the Secretary of the Interior, Prof. Dean C. Worcester.

VII. REORGANIZATION OF THE SERVICE OF SECONDARY STATIONS IN THE WHOLE ARCHIPELAGO.

Preliminary notes.—All the secondary stations in the Archipelago had been broken up during the second half of the year 1898. First of all the telegraph service failed, and a short time afterwards those in charge of the instruments were obliged to abandon them owing to the grave circumstances which were then developing and which made all peaceful life absolutely impossible in the provinces.[1] The last observations received in this center were those from the station at Albay corre-

[1] The fidelity with which D. Pablo Firaza, telegrapher and observer at Albay, fulfilled the duties of his charge is worthy of special mention. When it was necessary for him to quit the town, he took with him the instruments, and he kept them for several months hidden away on the slopes of the Mayon. He delivered them over to the secretary of the Meteorological Service, when the old station of Albay was reëstablished in Legaspi.

sponding to the two first weeks of November, 1898; so that from this date the old Meteorological Service of the secondary stations was utterly broken down.[1] It is to be noted that already in May, meteorological telegrams had ceased coming from the provinces, hence it resulted that for the work of forecasting the weather and issuing typhoon warnings, the Observatory for several months could only make use of the telegrams received from outside the Philippines, namely, five from the Island of Formosa; seven from stations in Japan and Liukiu Islands, three from the coast of China and four from stations situated in Indo-China.

Although the Meteorological Service of the Central Observatory was not interrupted for a single day in spite of the disturbances of the war, it is clear that the lack of telegrams from the secondary stations was greatly felt, especially those from the stations situated in the southeast and the more easterly coasts of the Archipelago.

On this account the Government of the United States, which was by this time established in Manila, lost no opportunity in causing observations to be made in different parts of the Islands by private individuals, as well as by the Army officials. On the other hand, the commanders of the squadron and the captains of the port, who had learned from their own experience the danger they ran, owing to the frequency with which the typhoon crossed these seas, soon saw the great convenience and even the necessity of knowing the state of the weather as soon as possible; and thus all concurred in trying to establish, in some sort, the meteorological service of the provinces.

The first cablegrams which were received after the interruption of the line were those from the two cable stations of Capiz, in Panay, and Tuburan, in Cebu. These observations, the employees of the cable office generously volunteered to make, and they commenced sending them in October, 1898.

Later on, in May of 1899, we began also to receive regularly by cable the observations from the captain of the port of Iloilo and in the following June from the captain of the port of Cebu.

In the middle of 1900, when several telegraph lines had been laid toward the north of Luzon, the commander of U. S. S. *Nashville* wrote to the commander in chief of the squadron, Admiral George C. Remey, who was at Cavite, asking him that the weather notes and warnings of the Observatory be sent to the principal ports of the Islands, proposing, as well, that the weather signals in use at Manila should be hoisted in the same ports. He insisted on the great benefit which would result to the navy and merchant marine during the typhoon season, which was then commencing.

Moved by the reason which had been proposed to him by the above-cited commander, Admiral Remey sent a communication on June 10, 1900, to the Captain of the Port of Manila favoring the petition of the commander.

The Captain of the Port of Manila at that time, Mr. W. Braunersrenther, indorsed the communication of the admiral and sent it to the Director of the Observatory, and the immediate result was that meteorological apparatus was sent to Aparri, Cabo Bojeador, Vigan, San Fernando, and Dagupan, all of them in the north of Luzon, and specially mentioned in the petition of the commander of the *Nashville*. Meteorological observations were taken in those places twice a day, namely at 9 a. m. and 3 p. m. Fr. John Doyle, the Director of the Observatory, proposed, moreover, that weather signals should be constructed identical with those employed in Manila; and these signals could be hoisted in the above-mentioned ports, according to the indications of the Observatory in the weather notes and warnings which it would send to those places. This the Captain of the Port of Manila did, and by the middle of June of the same year he had sent the signals to the different ports. The same service was then extended to other ports of the Archipelago. At the same time, in conjunction with the Hydrographic Office, which had just been established under the direction of Mr. Everett Hayden, an English edition was prepared of the explanation of the system of signals used throughout the Archipelago. This English edition was distributed, together with the Spanish one, that all the pilots might be acquainted with the weather signals.[2] For some time there had also

[1] In this, we refer to the official service; for private observers, mostly Jesuit missionaries in the Island of Mindanao, continued their observations till the time, when either on account of orders of superiors, or by reason of circumstances they were forced to retire. The last observations were from Fr. Fernando Diego, S. J., in April, 1900.

[2] Copies may be had from the Captain of the Port, the Observatory, and from the inspectors of customs in the province.

been a provisional observer, at Lucena, in Batangas, and at one other point whither, as soon as occasion offered, some apparatus would be sent. During this time, when observers were few, the observations of D. José Aparici, resident in Tuguegarao, were of the greatest utility. He began to send them by telegraph in August, 1900.

Catalogue of new stations.—All the meteorological stations we have just mentioned could only be worked with great irregularity, during the critical period of 1899 and 1900, and hence were only provisional stations, which had to be replaced by the new meteorological service. These stations, as is clearly explained in the law, were to be divided into four classes, all dependent on the Central Observatory at Manila. They are as follows:

CENTRAL OBSERVATORY, MANILA.

[Latitude 14° 34′ 41″ north; longitude 120° 58′ 33.15″ east of Greenwich.]

Height of barometer above the level of the sea, 14 meters.	Height of the thermometers in the tower above the ground, 18 meters.	Observations begun, November, 1865.

FIRST-CLASS STATIONS.

Town.	Province.	Latitude north.		Longitude east of Greenwich.		Height.	Observations begun—
		°	′	°	′	*Meters.*	
Aparri	Cagayan (Luzon)	18	22	121	34	6	Sept. 20, 1901
Baguio	Benguet (Luzon)	16	35	120	43	1,450	June 1, 1901
Dagupan	Pangasinan (Luzon)	16	04	120	19	4	July 9, 1901
Atimonan	Tayabas (Luzon)	14	02	121	51	7	Nov. 25, 1901
Legaspi	Albay (Luzon)	13	09	123	44	4.20	Dec. 9, 1901
Ormoc	Leyte	11	00	124	33	4.50	Sept. 17, 1901
Iloilo	Iloilo (Panay)	10	42	122	35	3	Dec. 11, 1901
Cebu	Cebu	10	18	123	54	3	Sept. 24, 1901
Zamboanga	Zamboanga (Mindanao)	6	54	122	03	7	Nov. 10, 1901

SECOND-CLASS STATIONS.

Town.	Province.	Latitude north.		Longitude east of Greenwich.	
		°	′	°	′
Santo Domingo	Batanes Islands	20	28	121	59
Cabo Bojeador	Ilocos Norte (Luzon)	18	30	120	33
Laoag	Ilocos Norte (Luzon)	18	12	120	37
Tuguegarao	Cagayan (Luzon)	17	35	121	39
Vigan	Ilocos Sur (Luzon)	17	33	120	20
Ilagan	Isabela (Luzon)	17	09	121	41
Cabo Bolinao	Zambales (Luzon)	16	29	119	46
Caranglan	Nueva Ecija (Luzon)	16	01	121	02
San Isidro	Nueva Ecija (Luzon)	15	22	120	53
Olongapo	Zambales (Luzon)	14	49	120	15
Daet	Camarines (Luzon)	14	04	122	56
Batangas	Batangas (Luzon)	13	45	121	03
Pasacao	Camarines (Luzon)	13	31	123	03
Sorsogon	Sorsogon (Luzon)	12	59	123	58
Romblon	Romblon	12	36	122	16
Catbalogan	Samar	11	48	124	54
Capiz	Capiz	11	36	122	42
Tacloban	Leyte	11	15	124	59
Concepcion	Concepcion	11	17	123	05
Bacolod	Western Negros	10	41	122	56
Maasin	Leyte	10	08	124	45
Surigao	Surigao (Mindanao)	9	47	125	29
Tagbilaran	Bohol	9	38	123	53
Butuan	Surigao (Mindanao)	8	55	125	31
Cagayan	Misamis (Mindanao)	8	26	124	42

THIRD-CLASS STATIONS.

Town.	Province.	Latitude north.		Longitude east of Greenwich.	
		°	′	°	′
Candon	Ilocos Sur (Luzon)	17	12	120	26
San Fernando	Union (Luzon)	16	37	120	19
Tarlac	Tarlac (Luzon)	15	31	120	35
Iba	Zambales (Luzon)	15	21	119	57
Arayat	Pampanga (Luzon)	15	08	120	46
Corregidor	Corregidor	14	24	120	38
Lucban	Tayabas (Luzon)	14	07	121	33
Nueva Caceres	Camarines (Luzon)	13	38	123	12
Tuburan	Cebu	10	44	123	48
San Jose Buenavista	Antique (Panay)	10	45	121	55
Dumaguete	Western Negros	9	19	123	17
Balingasag	Misamis (Mindanao)	8	45	124	44
Dapitan	Misamis (Mindanao)	8	38	123	24
Caraga	Davao (Mindanao)	7	30	126	32
Cottabato	Cottabato (Mindanao)	7	13	124	12
Davao	Davao (Mindanao)	7	01	125	35
Jolo	Jolo	6	33	120	59

RAIN-MEASURING STATIONS.

Town.	Province.	Latitude north.		Longitude east of Greenwich.	
		°	′	°	′
Cabo Engaño	Cagayan (Luzon)	18	35	122	06
Alcala	Cagayan (Luzon)	17	53	121	35
Carig	Isabela (Luzon)	16	40	121	38
Baler	Principe (Luzon)	15	47	121	34
Masinloc	Zambales (Luzon)	15	34	119	56
Porac	Pampanga (Luzon)	15	05	120	32
Marilao	Bulacan (Luzon)	14	46	120	56
Balanga	Bataan (Luzon)	14	41	120	35
Morong	Rizal (Luzon)	14	31	121	13
Cavite	Cavite (Luzon)	14	29	120	55
Santa Cruz	Laguna (Luzon)	14	18	121	24
Ragay	Camarines (Luzon)	13	48	122	46
Mamburao	Mindoro	13	16	120	32
San Pascual	Burias	13	08	122	58
Palanoc	Masbate	12	21	123	35
Borongan	Samar	11	42	125	25
Cuyo	Cuyo	10	51	121	00
Loon	Bohol	9	48	123	47
Puerto Princesa	Paragua	9	43	118	43
Mati	Mindanao	6	46	126	09
Isabela	Basilan	6	43	121	57

Establishment of the principal stations.—By May of 1901, when the law was passed, the war was over, and there was no difficulty in planning the erection of many of the secondary stations. Preference was naturally given to those of the first class, both on account of their importance and in fulfillment of the prescription laid down in section 12 of the law, which says: "The nine first-class stations shall be established by the Director immediately, and the other stations authorized in section 6 as soon as practicable."

The station at Baguio, Benguet, had been in full working order long before the date of the enactment of the law; and the observations made by D. Benito Razon have served to form the climatological study of that exceptional region, as can be seen in the first part of the present report.

In Dagupan, D. Toribio Jovellanos had himself mounted the station, which on the 9th of July of the same year assumed an official character.

First meteorological expedition.—Fr. Baltazar Ferrer, assistant director, accompanied by D. Basilio Lindo, a mechanic of the Observatory, and three observers, set out from Manila to Cebu, with all the apparatus to be installed in the Visayas Islands. When they arrived at Cebu the building of the captaincy of the port appeared very suitable for the location of the first-class station which was to be placed in that locality; though some repairs were necessary in the pavilion on the left of the principal building, which was the only part available.

The captain of the port saw the importance of the meteorological service, and, in view of the official documents in which the authorities of Manila recommended the local authorities to do all in their power to help in the work of establishing the service, he offered to put the pavilion in repair.

Fr. Ferrer then left Cebu, and having taken the opportunity which presented itself, he and his companion sailed for Surigao in the *Ilocos,* a small steamer belonging to the Compañía Tabacalera. They arrived there at noon of the 6th of August, and without loss of time visited the town that same evening. The house which the Madres del Beaterio were about to leave appeared to be a very suitable place as a station of observation.

One of the members of the municipality, D. Pio Caimo, a gentleman who took great interest in

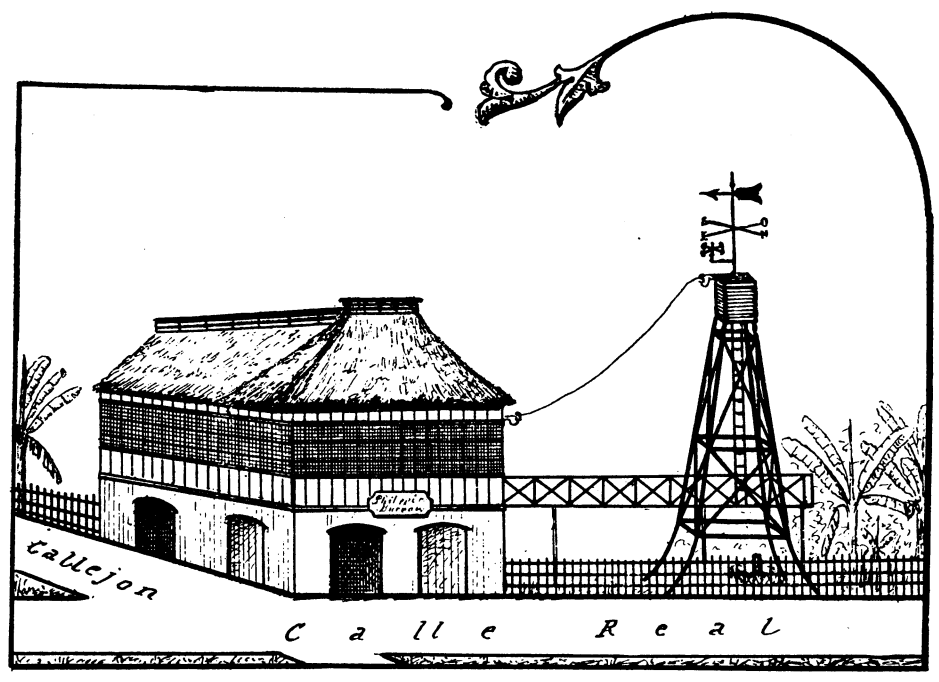


FIG. 5.—Exterior view of the first-class station at Ormoc.

meteorological work and to whom the Observatory owes a series of valuable observations of the baguios that have passed by the south, took up, with the greatest enthusiasm, the work of establishing the station at Surigao. This gentleman, who knew how to move the municipality in favor of this work, not only gave the building selected, but wished to bear all the expenses of the installation. On the 12th the apparatus was in full working order.

Returning to Cebu and, seeing the backward state of the work there, Fr. Ferrer determined to take advantage of the time and embark for Maasin, a port toward the south of the island of Leyte where a second-class station had to be erected.

The village of Maasin is situated at the foot of a range of hills, which runs from east to west, leaving it thus well sheltered from the north winds, a circumstance which, added to the fact that the houses are for the most part built among thick clumps of trees, made it difficult to find a site suitable for a station. A stone tower some 8 meters high, with a base of 5.60 by 5.15, offered somewhat better conditions. The tower was raised in the public square, isolated from the houses of the village and had been built more than a century ago to serve as a watch-tower whence the fleets of

the Moorish pirates, which so often devastated these coasts, could be seen; consequently it had a large horizon, and the winds blew relatively freer about it. The abandoned state of the building necessitated great repairs. The municipality ceded it as a station under certain conditions, which clearly showed the little interest it had in the work, though the building was of no use to them. Fr. Ferrer, believing it to be for the public good, acceded to the conditions and expended in the installation what the generosity and disinterestedness of the municipality of Surigao had given us, and paid for the expenses of repairs and installation, which were greater than had been estimated for a second-class station. The apparatus were put in position on the 28th, and on the 1st of September the observer began to send the daily observations.

Fr. Ferrer and his companion then returned to Cebu, because he wished to finish as soon as possible the installation in that place. Owing to causes over which those engaged in the work during his absence had no control, Fr. Ferrer found matters in almost the same state as when he had left them, and so, finding a steamer in the port which was about to start for Ormoc, he embarked the following day. Ormoc was fixed upon as a first-class station because the cable touches there, and this is an advantage even preferable to a better position on that coast, because thus the transmission of observations is assured even during the period of the greatest atmospheric disturbance.

Here Fr. Ferrer fulfilled the object of his visit quicker and with less difficulty than he had met with in the other places. He found there the observer, D. Pedro Baltazar, who had gone on some days before, installed in a house close to the sea, at a few steps from the cable station and public buildings, the house isolated from trees and large enough to serve as office and dwelling house of the observer, an advantage very desirable in a first-class station (fig. 5). This was owing to the efforts of the distinguished parish priest of Ormoc, Rev. D. Lino Codilla, who had persuaded the owner to give the house for this object. Not content with this, he showed himself truly enthusiastic for the work and put the house in repair at his own expense. The presidente of the municipality, D. Simplicio Fidel, and the secretary, D. Espiridion Restituto, emulated the enthusiasm of their worthy pastor for the establishment of the meteorological station and wished the expenses of the work to be put down to their account, provided that the station would be one of the best of its class. Work began at this station on the 17th of September.

This short memorial may serve to show our sincere gratitude to those gentlemen, and the town of Ormoc may well be proud of having such worthy authorities.

On his return from Ormoc Fr. Ferrer found the work on the station at Cebu well forward, and installed the instruments there so that on the 24th the ordinary observations were sent to the Central Observatory. Being recalled by telegram, he set sail with his companion on the same day, the 24th, for Manila.

Second expedition.—Without waiting for the return of the expedition to the Visayas, the secretary of the Meteorological Service, with D. Gervasio de Guia, observer of the Central Office, and D. Manuel Delgado, observer of the new station, set out for Aparri on the 27th of August, 1901, taking with him all the apparatus to be mounted there. As the boat stopped at San Fernando de la Union for a few hours, the opportunity was taken of overhauling the apparatus which had been working there several months, namely, a mercurial barometer, maximum and minimum thermometers, a wind vane, and pluviometer.

He arrived at Aparri on the 29th at nightfall, and soon it was seen how difficult it would be to find a suitable locality, because all the well-built houses and buildings were occupied. But the great and evident utility which must accrue not only to the town but to the commerce of the whole valley of Cagayan and reighboring province, from the erection of the meteorological station soon awakened the interest of many persons. We must make mention of Col. Charles C. Hood, who favored our work so much that he immediately ordered that a suitable site should be sought. The more favorable places were inspected and at last a solid and well-situated building was found, which was then occupied by the officers of the Military Government. Colonel Hood ordered that a part of this building necessary for the establishment of all the instruments for a first-class station should be given over to us; and thus, thanks to Colonel Hood, to whom we give our hearty thanks, the principal difficulty was overcome.

Third expedition.—A third meteorological commission consisting of Fr. M. Saderra Mata, assistant director, the author of this memoir, and several observers, left Manila on the 9th of October in the direction of Legaspi.

This town, situated in north latitude 13° 9′ and 123° 44′ longitude east of Greenwich, is very important, as far as its port is concerned, because it is the most frequented port in the rich Province of Albay. There are six large docks, which are very frequently occupied with steamers, taking in abacá, the exclusive product of this part of Luzon, and discharging commonly rice and other products. Some three years ago the number of inhabitants was greatly increased on account of the ruin which fell on the neighboring towns of Daraga and Albay during the war. Examining the local conditions several notable characteristics were found. Legaspi is situated at the innermost point of the gulf of Albay, open on the east, and exposed almost entirely to the winds between N. and ESE. We say almost entirely because the NE. winds have first to pass by the islands S. Miguel, Cacraray, Batan, and Rapurapu. Hence the prevailing winds in the Philippines, and especially those on the Pacific coast from November to May can be registered fairly well at Legaspi.

To the NW. rises the Volcano Mayon, on whose slopes, which are cleared from the very cone to the beach, stands the little town of Legaspi. This mountain, with its single perfectly formed cone, 2,522 meters high, continually offers many meteorological phenomena worthy of observation, especially the ascending, descending, and circular currents which are easily observed by the position, and movements of the smoke which is continually sent out from the higher mouth of the crater. The currents are also very much in evidence on account of the clouds which generally form on the sides of the mountain, and unite now on one side, now on another.

Moreover, it is clear that the presence of a volcano which constantly shows signs of activity, as does Mayon, holds exceptional importance in volcanological seismic science. Loud subterranean rumblings and eruptions of less importance are very frequent, and at intervals of a few years greater eruptions take place which put all the neighboring towns in danger and oblige the inhabitants to flee.

Following the configuration of the horizon we see that it extends on the west, from the slopes of the volcano to a small range of hillocks, which are in the form of an arc and limit the visible region to about three miles. In this small interlying plane were situated the towns of Daraga and Albay, of which, now in the midst of ruins, but a few houses remain.

Thus Legaspi is well sheltered from the winds which blow from the third and fourth quadrants, and in great part from those of the second, but is open to those from the first quadrant, and as these last are generally strong, the boats seek refuge in the old port of Lulat.

As for the town itself we can only say that it is built on a soil of blackish sand, a continuation of the beach, and is surrounded by water on all sides except the isthmus, which joins it to Albay. On this account it is often inundated during the high tides, especially if these are accompanied with copious rainfalls.

The instruments were installed in the house of the president, D. Balbino Belarmino, who deserves special mention here for having spontaneously offered a part of his house for this work.

The vane and anemometer were fixed on the roof thus: the height of the vane above the ground is 10 meters, that of the wind vane 9.5 meters, and that of the house 8.5 meters.

The thermometer stand is sheltered behind the house, facing the river. The pluviometer and nephoscope are placed on the terrace.

Finally, a simple seismograph was fixed to the lower part of one of the stone walls. Later on we shall place in this station a registering seismograph, which is suitable for registering the slightest seismic phenomena which the Volcano Mayon may cause. All these instruments, under the charge of D. Bernardino Costa, began to work on the 9th of December, 1901.

From Legaspi we passed on to establish another first-class meteorological station in Atimonan, which is a town in the Province of Tayabas. This province faces the Pacific, and encloses a large bay which is open to the winds from the first quadrant. In the center of the bay is the Island Alabat. This part of the coast of Luzon, which is well-known for its fertility, contains many important towns such as Mauban, Guamca, Lopez, Calaoog, and Atimonan, of which the latter, the center

of the mercantile business and station for boats, is the best known. It is situated 14° 2′ latitude north and 121° 51′ longitude east of Greenwich.

This town possesses, besides the advantage of being a commercial center, the further advantage of being better connected with Manila by telegraph than other towns. This makes it more suitable for a meteorological station, because the rapid transmission of typhoon notices is of the utmost importance. On this account it was thought advisable to establish the first-class station there instead of at Daet, as was originally proposed.

The local conditions of Atimonan are worth noting. The town, for the number of inhabitants, is very small, as it is inclosed in a plain of little extension. It is limited on the NW. by the river, which is continually plied by the craft of those who go to the fields. The rest of the horizon from

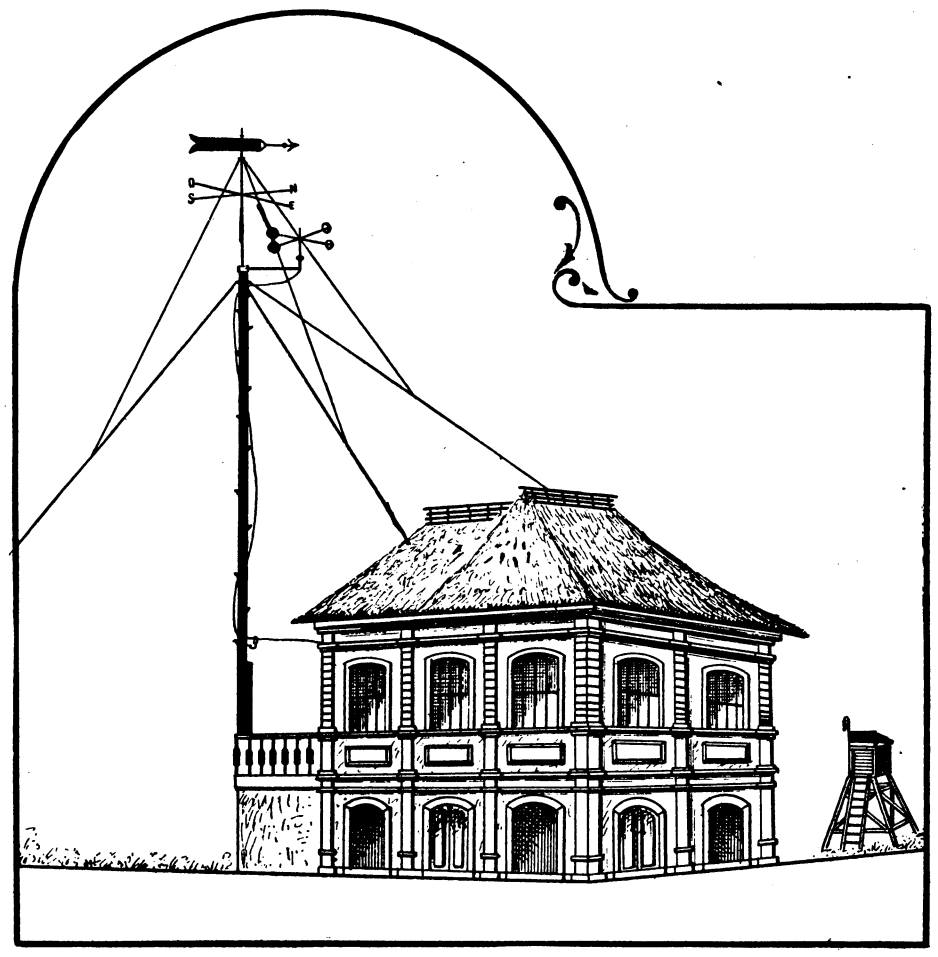


FIG. 6.—Exterior view of the first-class station at Atimonan.

east to west is shut in on the south by the almost perpendicular slopes of the mountains, which have the form of a horseshoe, so that some of the streets of the town climb up the very sides of the mountain. From what has been said it will be clearly understood that in this locality the winds from the NW.-SE. are not felt at all, or at most but slightly; but on the side of the bay it is perfectly open to the winds from the first quadrant. These winds, however, lose something of their violence in their encounter with the high cocoanut palms, which line the seacoast as if with a wall.

Taking into account the above-mentioned difficulties as well as the fact that there was no watch tower or other high building in the place, a house built of strong materials was chosen, which was situated in a central position and sufficiently isolated from the other houses of the town, and here

the apparatus were placed (fig. 6). The arrangement of the house is as follows: The stairs face the principal door, over which is written "Philippine Weather Bureau." There is a small board fixed to the wall close to the door, on which are placed the weather notices received from the central office. In the hall, which is a rectangle of some 40 square meters, are all the instruments which have to be placed under cover; the mercurial and Richard barometers and the anemograph were fixed to hexagonal columns near the windows in order to give them a certain amount of light.

The thermometer shelter, was mounted in a small yard which faced the stair side of the building and at a distance of some 3 or 4 meters away from it, since that was thought sufficient because there were no zinc roofs to reflect the heat into the shade. The thermometers, psychrometer, and vaporimeter were mounted in the usual form. In the same yard was also placed the pluviometer.

The greatest difficulty was encountered when we came to the fixing of the anemometer; for leaving aside the height of the mountain which did not allow the wind to come from the south, we had to meet that of the high cocoa palms on the beach, which stopped the winds from the north. There were virgin forests in the vicinity, so that the most practical and simplest plan seemed to be to go in search of a tree trunk which would overtop the palms and onto this fix the apparatus.

We must make mention here of the officer commanding this district, Capt. Charles Miller, Second Infantry, who placed at the disposal of the secretary of the Philippine Weather Bureau, the one charged with the work of erecting this station, the American launch *Des Moines* to bring a suitable tree trunk from the neighboring town of Calaoog. This short journey of twenty-four hours was undertaken with the further object of collecting information at first hand concerning the coast of the Island of Alabat, the position of the nearest mountain, and the passage of the Silanga, notable among other things for the tides which enter the Bay of Lamon by this channel and at times enter only on the Mauban side.

As to the erection of the tree trunk mentioned above, it is enough to say that it was fixed to an auxiliary support at the side of the terrace opposite the thermometer stand, and at the upper end were fastened three ropes in the manner shown in the sketch. The post was furnished with a series of steps to assist the ascent. The vane was placed at a height of 20 and the anemometer 17 meters from the ground.

Finally, the seismograph was fastened to the inside face of one of the walls of masonry which support the azotea. These walls are almost a meter thick.

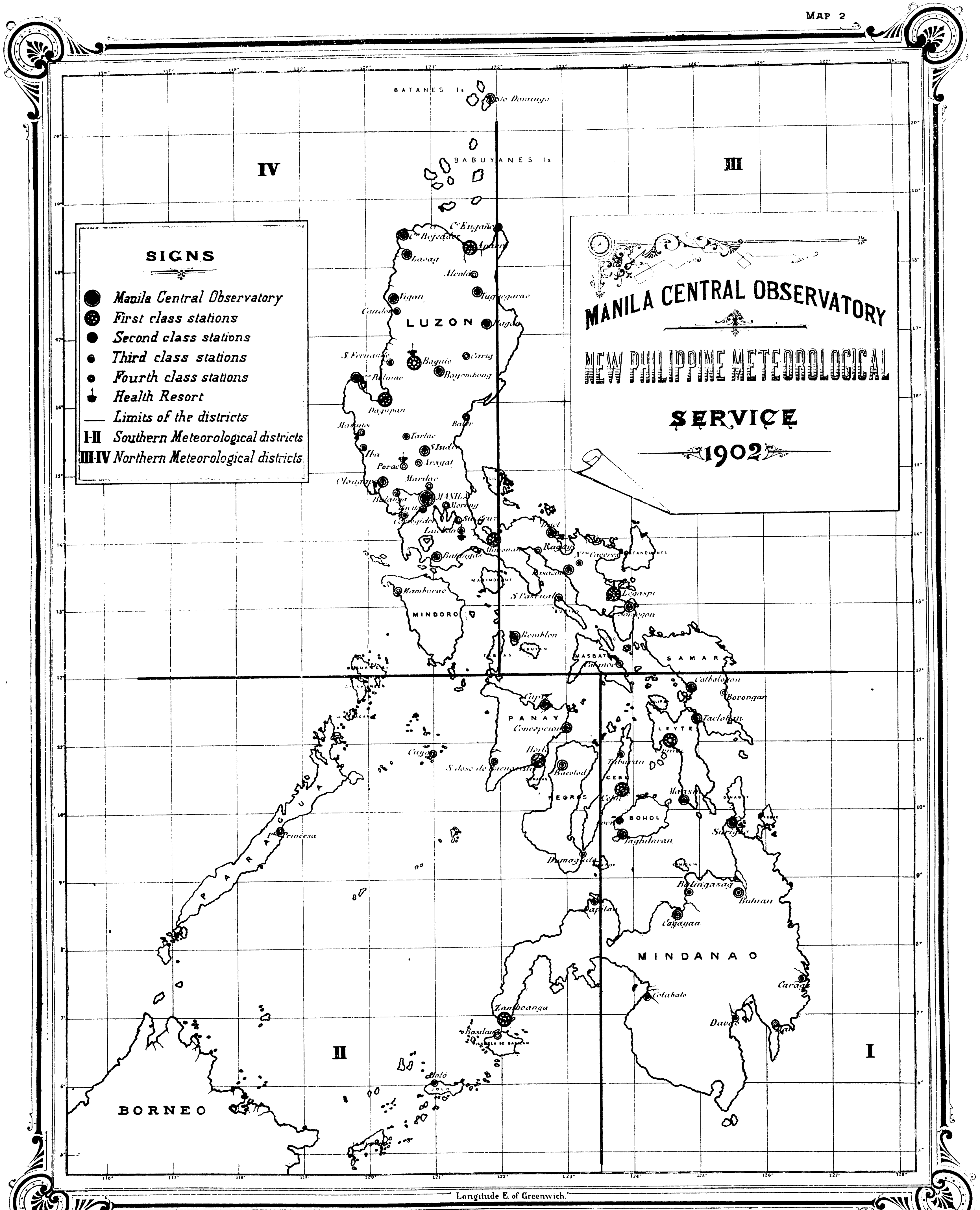
The work was finished on the 25th of November, and on that date all the apparatus was put into working order under the direction of D. Pablo Garcia, official observer.

The principal inhabitants repeatedly showed their interest in the meteorological station, especially the above-named commander, who said that it was his opinion that if the science of meteorology was useful in any part of the globe it was especially so in the Philippines, seeing that they were placed in the midst of such tempestuous seas, over which it is necessary to carry the great riches and products which are found in these countries. We will cite, among others, the names of D. Nicholas Pisa, D. Alejo Gregorio, and Sres. Arnalot, who helped in the installation, and D. Alfonso Cervantes, to whom the building which serves as the station belonged.

The great importance which the lumber trade has on this coast, and the ever-increasing production of cocoa and abacá, convinced us that the hopes which this people had in the beneficial results of a meteorological station will not be vain; since the usefulness of the new station will not be less than that of the one founded by Fr. Faura in 1885.

Fr. Saderra Mata, after leaving Legaspi for the South, established first of all the station of Tacloban, the capital of the Province of Leyte. Thanks to the assistance he received from the president of the municipality, he was able in a very short time to finish his task.

From Tacloban he passed on to Zamboanga, where he proposed to place another station. This town had been almost burned to ashes in May, 1899, and there remained only a few of the more strongly built houses, and all these were occupied by military officials. In spite of this circumstance, however, Gen. George W. Davis, at that time commander-in-chief of the troops in Mindanao, obtained a building suitable for the erection of a station. When he received the petition which had been sent to him for this purpose, the general kindly put at our disposal a part of the celebrated fortress of Pilar,


MANILA CENTRAL OBSERVATORY
NEW PHILIPPINE METEOROLOGICAL
SERVICE
1902
SIGNS
Manila Central Observatory
First class stations
Second class stations
Third class stations
Fourth class stations
Health Resort
Limits of the districts
I-II Southern Meteorological districts
III-IV Northern Meteorological districts
I
II
III
IV
BATANES Is.
BABUYANES Is.
LUZON
MINDORO
PANAY
NEGROS
CEBU
BOHOL
LEYTE
SAMAR
MASBATE
MINDANAO
PARAGUA
BORNEO
MANILA
Longitude E. of Greenwich.

which, being close to the sea and away from the town, had all the requisite conditions for the object in view. He also gave permission for the observer to live within the military lines, and provided him with the necessary passports.

The next station founded was that of Iloilo, one of the most important in the whole of the Archipelago. On the 2d of December Fr. Saderra embarked for Capiz, where there was already a second-class station, with the object of inspecting and improving the arrangement of the instruments.

We will now summarize in a few words what has been said concerning the establishment of the different stations. Toward the end of the year 1901 there were already founded fourteen stations, of which nine were first-class. Serious difficulties had been met with in this rapid reorganization of the secondary stations, owing on the one hand to the difficulty of land communication, and on the other to the great scarcity of fit subjects to verify with the requisite accuracy the observations taken. On this account several months were spent in training likely persons for the work of observing. This work the Observatory had anticipated by forming a class in meteorology, conducted by Fr. Baltazar Ferrer.

When the persons forming the class were well instructed in the necessary points of the subject, they were taught the practical part of the work, by using the instruments they were to have under their charge. As a consequence, good results were obtained at the first examination for observers which was held at the Observatory on the 10th of June, 1901.[1] Five were found fit to take charge of first-class stations, and several for the second-class.[2] These were then appointed and given their several posts as above said.

All the employees who were in actual employment in the Philippine Meteorological Service before the 22d of May, 1901, the date of the enactment of the law, were eligible for the work of observer without further examination, and several of the principal stations were given to their charge. The vacant posts in the central office were to be filled by those eligible for the first or second-class stations at the will of the Director.

During the course of the present year many more stations have been established, in proportion as new observers have been approved of in the different examinations.[3]

What we have said will be sufficient to give an idea of the establishment of the stations, and of the rapidity with which the work has proceeded notwithstanding the many difficulties and adverse circumstances it had to contend with. As the greatest difficulty was the lack of suitable buildings in the different localities, the Director of the Bureau proposed to the Secretary of the Interior that a law should be passed directing the provincial governors to provide suitable sites for the first and second-class stations. The text of this law, which was approved on March 4, 1902, may be seen in Appendix B.

The map of the new meteorological service.—In map No. 2 is found a graphic arrangement of all the stations forming the Philippine Meteorological Service.

We have already given in Paragraph VII the catalogue of these stations, together with their coördinates of latitude and longitude and the provinces to which they belong.

In the map, besides the signs to distinguish the different classes of stations, we have adopted a conventional sign to mark out the places chosen as health resorts, about which a special climatological study is made. At present, those stations are Baguio (Benguet), Porac (Pampanga), Lucban (Tayabas), all of them at a considerable height above the level of the sea and distinguished by exceptional climatological conditions. The study of the observations made with direct and self-registering instruments in those points will doubtless be of interest, especially for the many strangers who are now living in these tropical climes.

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[1] The members of the board of examiners for civil service presided over the examination.

[2] The observers of the third and fourth order are not subjected to the civil service examination. They are chosen at the discretion of the Director.

[3] Other details as to the establishment of the stations may be seen in the interesting description which Fr. Saderra Masó has given of his journey around the coast of Mindanao in the months of May, June, and July of the present year 1902. This paper will be included in the report of the United States Philippine Commission to the Secretary of War for the year 1902 in the chapter on the Weather Bureau.

In the map of which we are speaking only the stations officially erected acording to the law of May 22, 1901, are noticed. Prior to the 14th of October, 1901, the erection of stations directed by private observers was approved, but, although there are not a few of these, they are not marked on the present map, because they have not a fixed and definite character, as the rest have which have been erected by law.

In the same map may be seen the most recent division of the Archipelago into four meteorological districts, which are designated by the Romon numerals I, II, III, IV.

These districts are limited by the 12° parallel north and two perpendicular lines, one toward the south which almost coincides with the meridian 123° 30′ east of Greenwich, and divides the districts I to the east and II to the west. The other line toward the north, coinciding with the meridian 122°, forms the northern Districts III to the east and IV to the west.

Frequent mention is made of these meteorological districts in the monthly bulletin and weather warnings sent to different parts of the Archipelago.

VIII. INSTRUMENTS IN THE STATIONS AND THE WORK PERFORMED THERE.

The apparatus of the different stations.—Following the same system and order we adopted in describing the central office, we will first give some idea of the instruments placed in the secondary stations and then give a short account of the work done by them. The majority of the instruments are similar to those in use in the United States, and were kindly obtained by order of and under the direction of the Chief of the Meteorological Service, W. L. Moore, who has always shown the greatest interest in the reorganization of the Philippine Meteorological Service. In a letter sent to Fr. J. Algué, dated April 5, 1901, he said: "I assure you that you shall have our cheerful coöperation and our hearty good will in everything that we can do to further the interests of the meteorological service of the Philippines as administered under your able direction. Please make use of us for the purchase and shipment of any additional apparatus or materials that you may need from this country."

We can not do less than return to Prof. W. L. Moore our sincere thanks.

As the apparatus are well known, we shall not describe them here.[1] Later on we shall give a short description of the few instruments manufactured by the Observatory and which up to the present have not been noted.

The catalogue of instruments working in the first-class stations is as follows:

A mercurial barometer with the Fortin cistern; Green type.[2]
A barocyclonometer of P. J. Algué; English make.
A Richard barograph.
A Wirling psychrometer in an iron mounting.
Maximum and minimum thermometers with their mounting.[3]
Thermometer shelter, type employed in United States.
A Piché vaporimeter.
An anemoscope.
An anemometer with the Robinson mill.
A simple registering anemograph electrically connected to the counter by a Gordon pile.[4]
A spindle nephoscope.
A pluviometer on iron tripod.[5]

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[1] Consult the "Illustrated Catalogue of Meteorological Instruments and Apparatus, with Special Instructions, Julien P. Friez, Baltimore, Md., U. S. A."

[2] See the pamphlet "Barometers and the Instruments of Atmospheric Pressure," by C. F. Marvin, prepared under the direction of W. L. Moore, Chief, United States Weather Bureau.

[3] Described in the Report of the Chief of the Weather Bureau, 1891-92, page 28, Washington.

[4] See description in the pamphlet "Anemometry," by C. F. Marvin, Washington, Weather Bureau.

[5] It is described in "Measurement of Precipitation," by Marvin, Washington, Weather Bureau.

The apparatus for the second-class stations are generally:

A Tonnelot barometer.
A Richard barograph.
Maximum and minimum thermometer; United States type.
A psychrometer on a wood mounting, to which is fixed a small nickel vessel, such as is used in the United States.
A thermometer shelter; Manila Observatory type.
Vane and a Wild anemometer.
A spindle nephoscope.
Pluviometer on iron tripod; United States type.
A pendulum seismograph as modified by the Observatory.

The third-class stations have a typhoon barometer as modified by the Manila Observatory, instead of the Tonnelot barometer, and they are not furnished with the barograph or nephoscope. The rest of the instruments are as enumerated in the above catalogue.

On account of the importance which a knowledge of the rainfall has for an agricultural country, a series of fourth-class or rain stations have been established. Besides a pluviometer, these stations possess a typhoon barometer and maximum and minimum thermometers with their shelter.

The typhoon barometer.—The form of this mercurial barometer adopted for the third and fourth class stations is very simple (fig. 7). On each side of the vernier are placed two small plates, one of them fixed, the other movable. With this arrangement, Fr. Algué succeeded in applying to the mercurial barometer the advantages which the movable dial of his barocyclonometer possessed; for on the movable plate are engraved the readings relative to the typhoons, as is seen in the figure This plate can be raised or lowered by adjusting it by means of the screws which keep it in its place on the stand, in order to put the division marking the typhoon limit, indicated by a red arrow, exactly opposite the proper division on the fixed plate. This division varies with the latitude of the place and the time of the year. The barometric reading, which is the typhoon limit in the different latitudes and months of

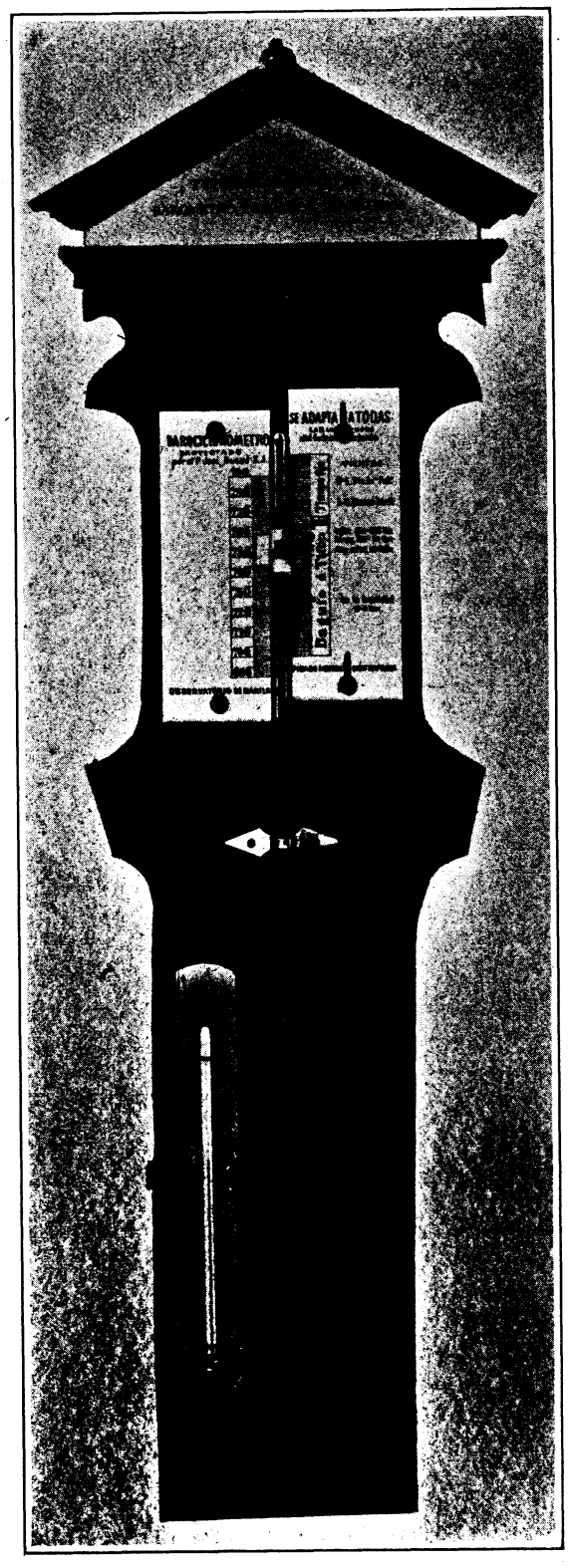

FIG. 7.—The typhoon barometer.

the year, is given in the following table. To understand this table, it is necessary to note that the first group comprises the months of December, January, February, and March; the second group, April, May, October, and November; and the third, June, July, August, and September. This table, being so important, accompanies every barometer, together with a few short instructions.

Between parallels.	Millimeters.	Inches.	Remarks.
(*a*) 0°–11° N.	756	29.76	All through the year.
(*b*) 11°–17° N.	756	29.76	During the months of the first group.
	755	29.73	During the months of the second and third group.
	757	29.80	During the months of the first group.
(*c*) 17°–21° N.	756	29.76	During the months of the second group.
	755	29.73	During the months of the third group.
	760	29.92	During the months of the first group.
(*d*) 21°–25° N.	757	29.80	During the months of the second group.
	753	29.65	During the months of the third group.
	765	30.12	During the months of the first group.
(*e*) 25°–32° N.	762	30.00	During the months of October and November.
	758	29.84	During the months of April and May.
	753	29.65	During the months of the third group.
	763	30.04	During the months of the first group.
(*f*) 32°–35° N.	758	29.84	During the months of the second group.
	754	29.69	During the months of the third group.
	761	29.96	During the months of the first group.
(*g*) 35°–40° N.	757	29.80	During the months of the second group.
	754	29.69	During the months of the third group.
(*h*) 40°–50° N.	756	29.76	All through the year.

The tube of the barometer is a siphon which, being easily raised and lowered, facilitates the correction for altitude. When the correction is not very great it is best done by lowering the movable plate till the readings of the plate are in accord with the reading of the barometer.[1]

To make the reading of these barometers simpler, the piece of metal which serves as a vernier is not marked with the ordinary divisions, but with a single one corresponding to the zero of the vernier. Although making it less accurate, this possesses another advantage, namely, that, as the reading is only approximate to the tenth of a millimeter, correction for temperature is unnecessary in the Archipelago when the level of the mercury in the siphon in normal weather reaches the height indicated on the paper instructions which accompanies every barometer.

Hence it follows that when the barometers are well installed the observer has not to add any correction to the simple reading in order to have the same approximate value of the atmospheric pressure as that given by an aneroid.

The typhoon-barometer by virtue of the modification we have just explained is as useful as any of the aneroids, because it is intelligible to all. The indications given by it are also more reliable than those of the aneroid, because the column of mercury is not subject to oxidation, and obeys readily the atmospheric pressure, which is not always the case with the lever of the aneroid.

The aneroid, on the other hand, possesses the advantage of being more portable, and consequently the more popular form; still, the mercurial one is preferable, at least on terra firma.[2]

Description of the thermometer shelter.—Two forms or types of thermometer shelters have been made use of for the stations in the Archipelago, as has already been indicated. The stations of the first class are provided with cube-shaped boxes made of wood louvre work, which are erected at a distance of some three meters from the ground. This is the United States type. For the rest of the stations in the Philippines we have adopted a simpler type, much less costly and more suited

[1] Whoever wishes a fuller explanation of the readings etched on the movable plate and how the limit reading of baguios varies in the Far East, may see the pamphlet in which the reason for the barocyclonometer is given, because what is said of that instrument can be applied to the typhoon barometer.

[2] Another advantage of the typhoon barometer is its relatively small cost. On this account a simple form of it has been made, so that the price will not be an obstacle to anyone's taking advantage of its utility.

to the tropical conditions of these Islands. The exterior is as seen in fig. 8.[1] Its base is rectangular or square, according to the instruments it is to contain, and its roof is prolonged equally on all sides.

The arrangement is very satisfactory, for, as the Archipelago is situated within the tropics and the southern part of it only distant 5° from the Equator, the sun is at each side of the zenith during a portion of the year in all the towns. The shelter has a double roof, the upper one of nipa palm, which experience teaches us is a very good material for isolating heat, as there is continually a current of air between the separate leaves. The lower part, which is of wood, is pierced with holes. Between the two covers there is an air space of moderate thickness. The roof is prolonged very much, and is out of all proportion with the rest; but this is an advantage, because as the roof prevents the rays of the sun from entering, the sides can be left open for about half their height, the other half being closed by louvre work. The floor is also about half open. With this system the best ventilation and the free circulation of the air is obtained, thus making the condition of the air inside the shelter correspond to that of the free air. The shelter can be fixed on four feet driven into the ground, but,

FIG. 8.—Thermometer shelter.

as it is so light, it is generally placed on a post. It should be placed at a height convenient for the observer to be able to open the door and observe the instruments. The arrangement of the instruments can be seen in the sketch. (Fig. 9.)

New seismographic pendulum.—We said in Paragraph III, when treating of the old Meteorological Service, that only those stations of the Island of Luzon connected by telegraph with the Central Observatory were properly meteorologico-seismic, although all the stations in the register of meteorological observations usually noted the principal earthquakes they had felt. In the new service, all the stations in the Archipelago are at the same time meteorological and seismical, as all of them are provided with a seismological apparatus with which they can analyze much better the earthquakes which occur with such frequency in almost the whole of the Archipelago.

[1] This type, as it is described, was designed by Fr. Baltasar Ferrer, Professor of Meteorology and Assistant Director of the Manila Observatory.

To extend the network of seismic stations to all the islands it was determined to erect at all the stations a seismograph of exactly the same pattern, so that the curves obtained from the different points for any one earthquake could be compared without the inconvenience of having to reduce them, as would be the case if different patterns of instruments were employed. It was, moreover, agreed upon that this pendulum should only be sensitive enough to record those movements of the earth which are perceptible to persons not moving about. By this we do not exclude the more perfect instruments; indeed so far from this being our purpose, we intend to place in some of what we might call the classic points of seismic activity, instruments of a much greater sensitiveness.

The seismographic pendulum adopted is a very simple one and scarcely needs explanation, except perhaps the form of suspension which is wholly original. This form of suspension, of which the details can be seen in fig. 10 in almost its natural size, consists of a spiral hanging from a strong support by means of the nut *a,* and fastened at the other end to a concave cone *c,* which rests upon a fine point *d,* which supports the weight of the pendulum by means of a ring *f*. The weight of the pendulum is fastened to the ring by means of a rod screwed into the ring. The piece *e* is bent in the form of an arc and carries a screw which serves as a support for the whole apparatus. The sensitiveness of the pendulum depends principally on the spiral which is the main part of the apparatus. The spiral itself consists of as many parts soldered together as there are rings.[1]

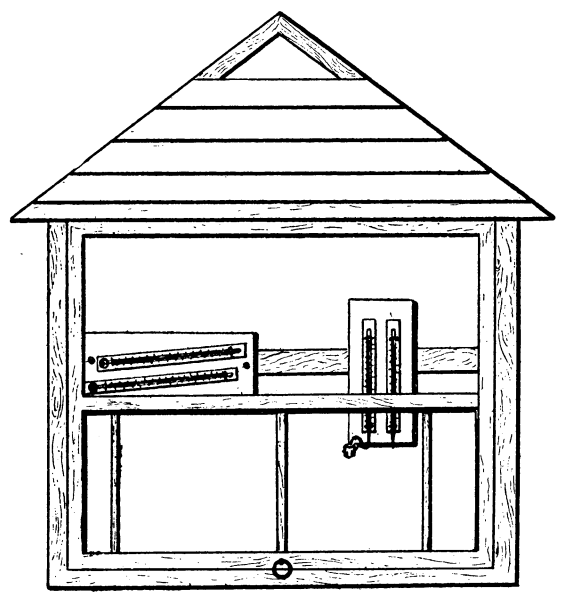

FIG. 9.—Sketch showing the arrangement of the instruments.

The suspension which we have just described has the property of keeping the pendulum in the same plane in which it begins to oscillate, so that the pendulum will remain swinging in the direction which the last impulse gave it, and if an earthquake has different directions these would be perfectly defined by the traces of the pen. Thus, if during the earthquake, there were no gyratory movements of the earth, the pendulum would not trace gyratory curves, a thing which the pendulums ordinarily employed do trace. Thus, if the movements of a pendulum with the cardan suspension be analyzed, it will be seen that the pendulum preserves the plane of oscillation when this coincides exactly with either of the two axes, but that, if it receives an impulse in any other direction, then the plane of oscillation gyrates till finally it coincides with one or other of the two axes, thus tracing a curve similar to that in fig. 11. It is to be noted, moreover, that in this class of suspension the pendulum tends to oscillate in the patch of one of the axes; and it has occurred that the pendulum has had to gyrate 60 degrees before the motion coincided with that of the axis to which it tended. A similar thing happens with the ring suspension.

When the pendulum is suspended by a thread or wire, it preserves the same plane of oscillation, but if several impulses succeed each other, the direction of these is not followed, but an intermediate one; and if it happens that the impulses are perpendicular to one another, then the resulting curve is almost circular.

All these inconveniences are almost entirely eliminated by the Observatory type of suspension, since the spiral which is included in the suspension prevents all gyratory motion which does not generally proceed from the earth. (Fig. 12.)

The only inconvenience resulting from the use of the spiral is that the apparatus is not so sensitive, but this can be regulated by changing the material of the spiral, the length of the pendulum, and the weight.

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[1] This form of suspension was invented in 1897 by Fr. Mariano Suarez, who made many experiments concerning it, in the spare moments which his work as missionary in Cottabato, Mindanao, left him.

In certain localities, which are more subject to earthquakes, besides this pendulum, clockwork seismographs have been mounted in order to obtain an automatic registration, at the moment the earthquake begins. This point, which is so important and so difficult to obtain outside of full-equipped observatories, has been made easier for the stations of the Archipelago by means of the daily transmission by telegraph of the official time, a service which was begun in the middle of September, 1899.

Telegraphic service.—In the law above mentioned, passed by the Civil Commission of the United States in the Philippines on the 22d of May, 1901, the observations and work to be done by those in charge of the different stations was laid down in a general manner only, so that it left to the Director to fix the number and order of the observations, as well as to specify the class of work to be undertaken by the observers. The Director therefore compiled a little book of short instructions[1] which was printed shortly after the date of the decree, i. e., May 31, and they were based, as was proper, on the text of the law.

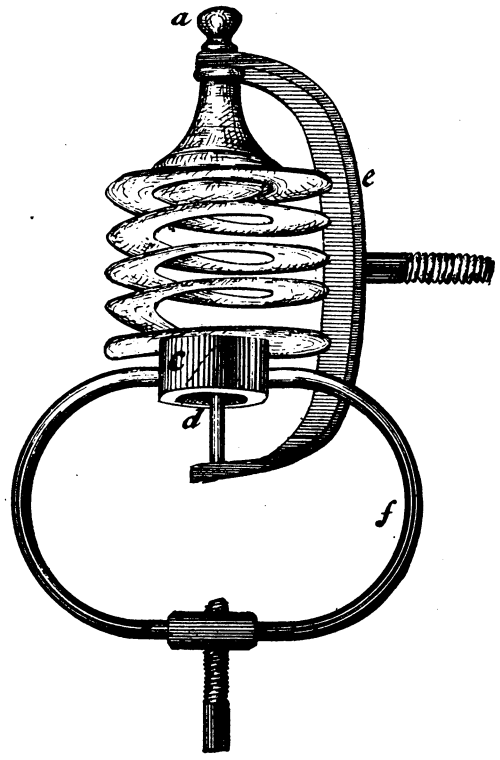

FIG. 10.—New form of suspension.

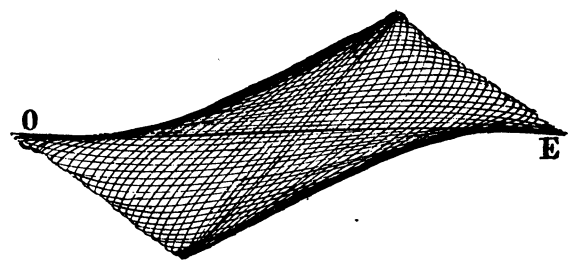

FIG. 11.—Seismographic curves.

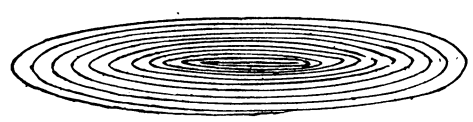

FIG. 12.—Seismographic curves.

As to the daily telegrams, it was ordered in conformity to sections 8 and 9 that the officials of the first and second class stations should send to the Central Observatory, by telegram, their observations three times a day, namely, at 6 a. m., 10 a. m., and 2 p. m., mean time of 120° east of Greenwich, and those of the third-class stations twice a day, at 6 a. m. and 2 p. m.

The Director multiplied the number of these services in certain cases as he thought convenient.

These telegrams were for some time written in the following form, similar to that used in the old service:

March 10, 6 a. m.

59.8 = Barometer corrected for temperature and reduced to sea level.
27.5 = Thermometer in the shade.
NE.5 = Direction and force of the wind.
8 = How much sky covered.
Ci.E. = Cirrus clouds from the east.
A-Cu.NE. = Alto-cumulus clouds from NE.
Cu.NNE. = Cumulus from NNE.

[1] The title is "Breves instrucciones para los Jefes de las Estaciones Secundarias de la Oficina Meteorológica en el Archipiélago Filipino."

o.p. = Cloudy weather and passing rain.
H. = Heavy sea.
25.2 = Amount of rain fallen since the last telegram.

We said that this form was in use for a time only, because, to facilitate the transmission of the telegrams from so many stations, a new code was made out and began to be employed toward the end of 1901.

By means of this code the above telegram was reduced to four groups of figures, of which the first consisted of four numbers expressing the day of the month and the hour, counting from 0, or midnight, to 24 o'clock. The three other groups consisted of five figures each, for example:

0620; 59827; 20216; 57756.

In the second group, the first three figures represent the barometer reading, the last two, the thermometer, v. g., 59.8 mm., 27° C. The first three figures of the third group express the direction and force of the wind, according to the key *a* and *b*, while the fourth and fifth figures of the same group give the class and direction of the higher clouds, according to the keys *c* and *d*.

WIND.					
(*a*) Direction.	(*b*) Scales of the velocity.				
	Terrestrial.	Beaufort.	Meters per second.	Miles per hour.	Action of the wind.
00 = Calm	0	0	0– 1.3	0– 3	Calm.
02 = NNE. 18 = SSO.	1	1	1.3– 3.6	3– 8	Light air; wind which is perceptible, will move a pennant.
04 = NE. 20 = SO.		2	3.6– 5.8	8–13	Light breeze; blows out a pennant and moves the leaves of trees.
06 = ENE. 22 = OSO.	2	3	5.8– 8.0	13–18	Moderate; moves the branches of trees.
		4	8.0–10.3	18–23	
08 = E. 24 = O.	3	5	10.3–12.5	23–28	Fresh; moves large branches and small trunks of trees.
		6	12.5–15.2	28–34	
10 = ESE. 26 = ONO.	4	7	15.2–17.9	34–40	Gale; moves the whole tree.
12 = SE. 28 = NO.		8	17.9–21.5	40–48	
	5	9	21.5–25.0	48–56	
14 = SSE. 30 = NNO.		10	25.0–29.1	56–65	Hurricane.
16 = S. 32 = N.	6	11	29.1–33.5	65–75	
		12	33.5–40.3	75–90	

Clouds.		(*e*) Weather.	(*f*) Sea symbols.	(*g*) Rainfall.
(*c*) Class.	(*d*) Direction.			
				mm.
0 = Without clouds.	0 = Without movement.	0 = b = Clear blue sky.		0 = 0– 0
High clouds. 1 = Ci. = Cirrus.	1 = NE.	1 = c = Cloudy weather.	1 = S = Smooth sea.	1 = 0– 5
High clouds. 2 = Ci. S. = Cirro-stratus.	2 = E.	2 = d = Drizzle or light rain.	2 = L = Long rolling sea.	2 = 5– 10
High clouds. 3 = Ci. Cu. = Cirro-cumulus.	3 = SE.	3 = l = Lightning.	3 = T = Tide-rips.	3 = 10– 15
High clouds. 4 = A. Cu. = Alto-cumulus.	4 = S.	4 = o = Overcast.	4 = M = Moderate sea or swell.	4 = 15– 25
Lower clouds. 5 = Cu. = Cumulus.	5 = SO.	5 = p = Passing showers of rain.	5 = H = Heavy sea.	5 = 25– 35
Lower clouds. 6 = S. Cu. = Strato-cumulus.	6 = O.	6 = q = Squally weather.	6 = R = Rough sea.	6 = 35– 50
Lower clouds. 7 = Cu. N. = Cumulo-nimbus.	7 = NO.	7 = r = Rainy weather or continuous rain.		7 = 50– 70
Lower clouds. 8 = N. = Nimbus.	8 = N.	8 = t = Thunder.		8 = 70–100
		9 = u = Ugly appearance or threatening weather.		9 = 100–500

In the fourth group the two first figures give the dominant class and direction of the lower clouds, according to the keys *c* and *d;* the third figure gives the state of the sky, the fourth the state of the sea, and the fifth, the amount of rainfall as is indicated in the keys *e, f, g.*

To the groups already explained the observer may add a fifth when he wishes to indicate that there is a notable convergence of true cirrus clouds. He then makes use of table *a* to denote the point to which they are converging; thus to express "Convergence of cirrus to SE" he would use 112.

When there is an earthquake, it is indicated by a special group of five figures in the following manner: 19354; the two first expressing the hour, the next two the minutes, and the fifth the intensity, according to the following tables *h*, *m*, and *i*.

(*h*) Hours. 0-24.	(*m*) Minutes.	(*i*) A scale for determining the intensity of an earthquake by the effects it produces.	
		Amplitude in degrees.	Characters.
00 = m. n. 12 = m. d. 01 = 1 a. m. 13 = 1 p. m.	01 = 1 02 = 2	1 = Perceptible (from 0° 0′ to 0° 10′)	A movement perceptible by persons at rest, accustomed to these phenomena and registered by the seismograph.
02 = 2 a. m. 14 = 2 p. m. 03 = 3 a. m. 15 = 3 p. m.	03 = 3 04 = 4	2 = Light (from 0° 10′ to 1°)	A tremor causing a slight movement and noise in light movable objects, such as doors windows, etc., and experienced by a man in motion.
04 = 4 a. m. 16 = 4 p. m. 05 = 5 a. m. 17 = 5 p. m.	05 = 5 06 = 6	3 = Weak (from 1° to 4°)	A tremor felt by every one in the vicinity. Movement of heavy articles, such as, beds, etc.
06 = 6 a. m. 18 = 6 p. m. 07 = 7 a. m. 19 = 7 p. m.	07 = 7 08 = 8	4 = Strong (from 4° to 10°)	Movement strong enough to awaken sleepers, swinging of lamps, stopping of pendulum clocks, the sounding of bells, the falling of heavy objects.
08 = 8 a. m. 20 = 8 p. m. 09 = 9 a. m. 21 = 9 p. m.	09 = 9 10 = 10	5 = Violent (from 10° to 18°)	Shocks which produce cracks in walls of solidly built houses, cause chimneys and towers to fall and hurl heavy objects from their places, with great force.
10 = 10 a. m. 22 = 10 p. m. 11 = 11 a. m. 23 = 11 p. m.	11 = 11 60 = 60	6 = Destructive (from 18° upward)	The partial or complete destruction of buildings, the opening of fissures in the ground, landslips, etc.

Daily observations.—In conformity with what was ordered in Section 9 for the second-class stations, six daily observations are made, distributed during the day and night as follows: 2 a. m., 6 a. m., 10 a. m., 2 p. m., 6 p. m., and 10 p. m. Distributed in this manner, the means deduced from them are of greater scientific value. The same number of direct observations are made in first-class stations and at the same hours; but by means of the self-registering apparatus, we have, as well, hourly observations of the chief meteorological elements as was prescribed in Section 8.

In the third-class stations the observations are made only at 6 a. m. and 2 p. m., except when the Director judges it fitting that they should be repeated oftener.

In Section 11 it was clearly specified that at the rain stations the maximum and minimum temperature should be daily taken, and that the barometer should be read daily at 6 a. m. and 2 p. m., as well as the quantity of rain collected in the pluviometer on rainy days.

To make sure that the observations be made exactly at the specified times, and as well as to check the working of the automatic apparatus, the official of each meteorological station must compare his watch with the time which is sent daily at 11 a. m. to the telegraphic office, according to the order given in Section 14.

Printed forms are sent to all the stations, and these have to be filled in by the hourly observations, according as the number and class of instruments installed in each station allows.

The monthly report.—The eighth and ninth Sections of the Act prescribed that the officials in charge of the first and second-class stations should make every month a report, taking as a model that which up to the present has been published by the Central Observatory of Manila. It consists of the following parts:

(1) One page of general observations, like that published hitherto in the Spanish Report of the Central Observatory.

(2) In the first-class stations hourly observations are taken from the registers of the barograph, thermograph, and anemograph. With these a table can be formed of the barometer, thermometer, and wind exactly like that in the Central Observatory Bulletin; placing at the foot of the table the means corresponding to each of the twenty-four hours, and in the last column, on the right, the mean of every day deduced from the twenty-four observations.

The employees in the second-class stations make their tables of atmospheric pressure, temperature, humidity, vapor tension, winds, and clouds like the tables of Manila, but smaller; for while the tables of the latter consist of twenty-four daily observations, the former comprise only six. At the foot of every table is written the mean of the six hourly observations and in the last column the mean of every day, deduced from six observations. The officials of the first-class stations have to make exactly similar tables of the values of those elements for which they have not self-registering apparatus.

(3) At the end of the report of the stations of the first as well as those of the second-class there is a table of all the extreme readings, frequency of winds, rain, evaporation, storms, etc., like that published on the last page of the Spanish Report of the Central Observatory.

(4) At the end of the year an annual résumé is made in all respects like that of the Central, and this is published as an appendix to the annual volume of the Report.

Those in charge of the third-class stations fulfill what was ordered in Section 11, by forming at the end of every month a table like to that which the Central Observatory published before May, 1898, in which the two daily observations of the secondary stations of Luzon were included; and at the foot of the table the monthly means; those two daily observations are at 6 a. m. and 2 p. m.[1] All these observations, as well as those made in the Central, are made in the metric system.

The recording of earthquakes.—All the stations of the Archipelago in the new Service are considered to be also seismic, as we said when treating of the apparatus; consequently in all of them a register is kept in which are noted, as minutely as possible, all earthquakes, however small they may be, provided they be perceptible. The hour is noted, the duration, the character and direction of the movements, and finally the intensity. The last three data can be easily deduced from the curves of the pendulum, except when the motion is purely vertical. The hour and the duration is easily obtained automatically by means of a simple seismoscope which consists essentially of a paper-covered cylinder moved by clockwork, and an electric current, the circuit of which is closed by the movements of the pendulum.

When the observer does not possess a seismoscope he can get the hour and the direction by quickly looking at the clock when the first shock is felt. To express the intensity a simplified Rossi-Forel scale is used, in which, instead of the ten grades of the original, only six are employed. For the rest of the data, to make the notes on the earthquake as complete as possible, the observers are directed to give a minute description, not only of the effects of the earthquake itself, but also of the accompanying phenomena, such as subterranean rumblings, volcanic and electric phenomena, the latter being the telluric or atmospheric currents commonly introduced into the telegraph and telephone lines.

The directors of the stations are obliged to remit to the Observatory, as soon as possible, all the above-mentioned observations, meteorological as well as seismical, and all the other work, together with records of the clockwork instruments, retaining the originals or a copy for their own archives. All this correspondence is sent in special envelopes with which the stations are provided.

The crop service.—On account of the close connection there is between meteorology and agriculture, it is well to unite the study of the climate of a country with an analysis of the good or evil effects the various meteorological elements exercise on the crops. This crop service, in the manner it is practiced in the United States, was joined to the meteorological service in virtue of the Act of its reorganization. The crop service began in the Philippines in August, 1901; as can be seen in the Bulletin for September, and the Bulletins since that time, it has greatly increased and is being

[1] The observations taken in the different stations since the official reorganization of the meteorological service will begin to be published in the third part of this report.

extended to the whole of the Archipelago, in proportion as the new stations are established, so that now at the middle of the present year, the whole Archipelago is comprehended in this service.[1]

A circular letter, copies of which were spread broadcast among the presidents of municipalities, landowners, and other influential persons in the different districts, asking them to give their assistance, helped greatly to the speedy organization of this service. The questions contained in the letter may be reduced to three heads:

1. The agricultural products which were specially cultivated in the region where information was sought.

2. The actual state of the crops, whether good, moderate or poor, and whether the crops have been benefited or damaged by the rains, winds, and the temperature.

3. Whether the plantations have been visited by any noxious insects, noting especially the presence of the locust, which so often devastates the plantations of these countries. Information was also asked concerning cattle diseases which cause considerable losses.

It is to the interest of the president and landowners to look with favor on this service and to answer the questions put to them concerning the crops, because all the data which is communicated must redound to their own good, and to that of the country in general. By means of the information, they make known, on the one hand, their agricultural products, thus favoring their exportation, and on the other the foodstuffs they lack, thus inviting their importation.

Besides the good the crop service can do to the natives, we can say that it is very useful and even necessary in view of the circumstances of the change of government in these Islands. In the days of the Spanish Government the crop service was joined to the *Servicio Agronómico,* which published in its "Boletin Oficial Agrícola de Filipinas" the state of the crops in the different parts of the Archipelago. This publication, which was a monthly, appeared for the first time in January, 1894.[2]

When the publication was discontinued in 1898 it was not possible to obtain any information regarding the products of the country till peace was restored, when the work of agriculture was once again resumed. Hence it is clear how convenient and even necessary it was, to establish a crop service in order to inform the newly constituted Government and numbers of strangers who were eager to know the products of the country, the state in which agriculture then was.

In Sections 8, 9, 10, and 11 of the law of reorganization of the Philippine Meteorological Service, it was prescribed that the employees of the secondary stations should send every month to the Central Observatory of Manila a short but as complete a report as possible of the state of the crops and the influence the weather and climatological conditions had upon them. And the reports were to be not merely of the town in which the station was placed, but also of the surrounding regions which were not comprehended in the jurisdiction of the nearest observers. These reports grew day by day more numerous and complete and were published monthly according to districts, stations, and municipalities.

Father William Stanton, to whom this work is intrusted, has endeavored to study, classify, and collect the insects prejudicial to agriculture in these tropical regions. To assist him in getting together specimens he sent out a circular in which he gave a description of the noxious insects he wished to obtain, and he added notes on the method of preserving them and of sending them to the Central Observatory at Manila, that he might study them. The circulars were distributed by the observers. Some results have been obtained, but the amount of material sent from the provinces is small and the notes accompanying it have been rather vague and unsatisfactory. The work that has been done in this matter will be published later on for the information of those interested in this subject.[3]

Typhoon warnings.—We have already said, when treating of the work performed in the central office, how the note which is published daily concerning the probable weather of the coming twenty-

[1] How the crop service has increased from month to month may be seen in the series of Bulletins from September, 1901, onwards.

[2] The title was "Boletin Oficial Agrícola de Filipinas redactado por los Ingenieros y Ayudantes del Servicio Agronómico." Tipo-Litografía de Chofré y Comp.

[3] Fr. W. Stanton has in preparation some notes on the economic entomology of the Philippines.

four hours, is sent by telegraph to the principal stations of the Archipelago, where the respective observers place them in public view that everyone who wishes may see them. Besides this, when there is any atmospheric disturbance, notice is at once given not only to the Captain of the Port of Manila, but also to the chiefs of the other ports in the Archipelago, in communication with the Observatory. In these warnings, which, as is clear, are different for different points of the Archipelago, the Director of the Meteorological Service, generally specifies the region toward which the storm is tending, and indicates the places most threatened, or those which will probably suffer the most. At the same time he determines which storm signal is to be hoisted in each locality.

The day as well as the night signals which are used in the ports of these Islands are the same which have been used for many years past in the port of Manila.[1] As may be seen in Plate VIII, they are eight in number, and their meaning following the same order in which they are placed is as follows:

1. *Indications of a distant typhoon; movements uncertain. Look out for the next signal.* Vessels prepare to strengthen their moorings. Steamers prepare to get up steam. Small vessels remain in port.

2. *Typhoon passing to northward at considerable distance. Strong winds from third quadrant (west to south.)* Vessels strengthen moorings and send down light yards and masts. Steamers get up steam. Dangerous for small vessels to be under way.

3. *Typhoon passing to southward at considerable distance. Strong winds from second quadrant (east to south).* Winds generally less severe than for signal No. 2, but same precautions required.

4. *Typhoon likely to be dangerous. Look out for next signal.* Strengthen moorings. Send down topsail yards and topmasts. Use steam if necessary. Small vessels remain at moorings.

5. *Typhoon passing to northward very near. Strong gales from northwest to southwest.* Strengthen moorings as much as possible. Lower and secure all gear. Use steam to help anchors. No vessels under way.

6. *Typhoon passing to southward, very near. Strong gales from northeast to southeast.* Gales generally less severe than for signal No. 5, but same precautions required.

7. *Typhoon center very near. Dangerous gales and heavy squalls.* Precautions same as for signals Nos. 5 and 6.

8. *Storm wave, very high tides and floods.* No vessels can come in or go out of port or move about the harbor.

Conclusion.—Summarizing what has been said, we find: That the Philippine Meteorological Service began as a private center in the year 1865, that it acquired its official character under the Spanish Government in 1884, and that its reorganization dates from the time the law was passed by the Civil Government of these Islands, namely May 22, 1901. The total number of stations, not including private observers, is 72, distributed over an area of 298,800 square kilometers. The plan of reorganization has been carried out in conformity with that drawn up by the Director of the Observatory of Manila, Fr. J. Algué, and Prof. W. L. Moore, Chief of the Meteorological Service of the United States.

The Government of the United States, to whose credit it is to have reëstablished the Philippine service, does not count its work finished, for that work will not be finished till, as pointed out by the Secretary of Agriculture, Mr. Wilson, to the two Directors, the Marianas be joined to the Philippines by cable, these with other islands and with San Francisco; in fine, till the meteorological network extends from one end of the Pacific to the other. This extensive plan, whose realization is perhaps not far distant, must give surprising results, and help in great measure all maritime and commercial interests. Doubtless when this comes to pass, secrets of meteorology which at present lie hidden in the great Pacific, will then be discovered, and no atmospheric variation of any moment will occur in the Far East about which the Manila Observatory, owing to its advantageous position in the track of the terrible typhoons, will not be able to render an account.

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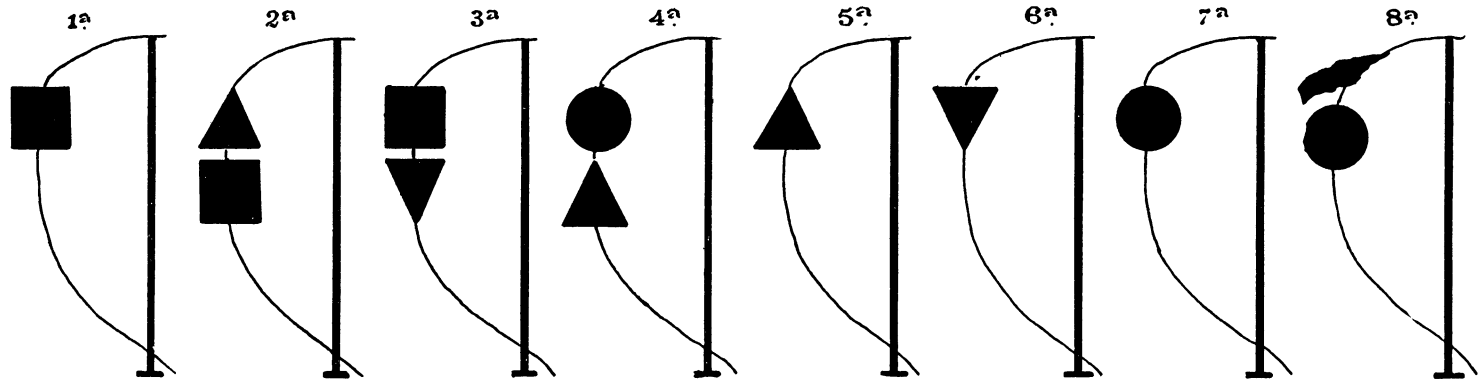
[1] Regarding the size of the day signals the cylinder measures 1½ feet in diameter and 2 feet in height. The cone has a base of 1½ feet diameter and is 2 feet high. The sphere is 2 feet in diameter. The flag of 3 or 4 square feet may be of any color.

TYPHOON AND FLOOD SIGNALS USED IN THE PHILIPPINE ISLANDS

DAY SIGNALS



NIGHT SIGNALS

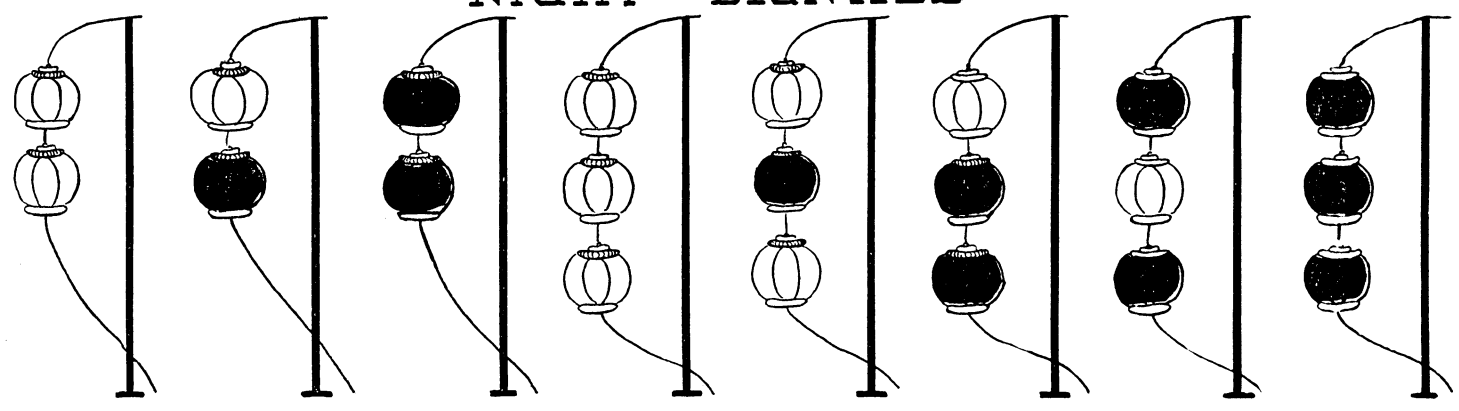


PLATE VIII.

APPENDIX A.

REPORT OF LIEUT. W. D. CONNOR, U. S. ENGINEER CORPS, TO GENERAL OTIS, CONCERNING THE MANILA OBSERVATORY.

MANILA, P. I., *March 22, 1899.*

SIR: In compliance with the second indorsement of a document (L. R. No. 2504, P. M. G. O.) of your office dated March 7, 1899, I have the honor to report as follows:

The work of this institution is divided into four departments:

I. Astronomical department.
II. Meteorological department.
III. Seismical department.
IV. Magnetic department.

Of these the astronomical department has just been added, and on account of this the estimate for funds as submitted is larger than it has been in previous years. The time of mean noon is given to the Captain of the Port daily, and also to the public by means of the ball which falls daily at mean noon. Chronometers for ships are rated in this department free of charge. The scientific work of this department is that usually done in a first-class observatory.

The meteorological department is the one in which the greatest amount of work is done, and the one through which the Observatory obtained by royal decree the right to governmental aid. Besides the usual observations taken in such an institution, which furnish invaluable scientific information in regard to the country, the typhoon predictions have made this Observatory famous throughout the East, and furnishes information to navigators which prominent merchants of Manila declare has saved them thousands of dollars by their timely warning. They, together with the Captain of the Port, say that the information given is necessary and valuable, and can not be obtained from any other source in the country.

The seismical department furnishes information and data in regard to earthquakes which so frequently visit this country.

The magnetic department is peculiarly fortunate, situated almost on the isogonic line, is especially sensitive to the slightest magnetic storms or disturbances, and the information obtained from this department is of great scientific value.

The buildings for the institution have been built by the Jesuit Brotherhood of the Roman Catholic Church, and were by them supported entirely until 1884. The instruments are almost wholly the property of this Brotherhood, as the money obtained from the Spanish Government for purchasing instruments was expended in setting up substations on the various islands of the Archipelago. The government of the institution is under a Director and subdirector, nominated by the head of the Jesuit Mission here, and confirmed by the Governor of the Islands, and appointed by the Spanish Government at Madrid. The employment of all other persons connected with the institution was made by the Director and confirmed by the Governor here.

The Spanish Government in 1896 set aside $19,838 for the use of the Observatory and its substations in the other islands. Of this sum about $3,000 was for the use of the substations; the remainder covers the same ground as is covered in the petition of Father Algué. The petition by Father Algué is $23,484 per year, a difference of $6,646; but as this estimate is made taking into consideration the astronomical department, which had not yet been recognized by the Spanish Government, and the increased wages due to the existence of war, the items which he asks to be paid by the American Government are practically the same as those paid by the Spaniards.

In the royal decree by the Spanish Government on April 28, 1884, the first article creates the meteorological service in the Islands, and attaches it to the Observatory of the Jesuits under the government heretofore described, and states that the particular work desired is the prediction of, and information in regard to, typhoons. The second article states where the substations shall be erected. The third article places the thirteen substations under the direction of a central administration in Manila. The fourth article prescribes that the employees shall be nominated and appointed as before described. The fifth article gives the salaries of the officers and employees of the Observatory, and states different amounts to be expended for different objects. The sixth article states that one-third of this appropriation shall be paid from the Spanish state funds, and the remaining two-thirds to be paid by the Government from the local funds of the Island. Article 7 provides for the creation of these stations as circumstances may require. The eighth article that, inasmuch as the stations established do not cover all of the islands, all naval stations shall be constituted substations as far as possible, and send their reports to the Director in Manila.

The Observatory in Manila therefore appears to be owned by the Jesuits and supported by the State. The Director says that the institution received aid from time to time from the Superior of the Mission, to whom it is now in debt, and as the work to be carried on is so extensive it will be impossible to continue their labors without governmental aid.

Very respectfully, your obedient servant,

W. D. CONNOR,
Lieutenant, United States Engineering Corps.

The ADJUTANT-GENERAL OF THE PROVOST-MARSHAL-GENERAL.

APPENDIX B.

AN ACT PROVIDING FOR THE FURNISHING OF ROOMS FOR THE INSTALLATION OF FIRST AND SECOND-CLASS STATIONS OF THE PHILIPPINE WEATHER BUREAU BY PROVINCIAL AND MUNICIPAL GOVERNMENTS.

By authority of the President of the United States, be it enacted by the United States Philippine Commission, that:

SECTION 1. In each province where a first or second-class station of the Philippine Weather Bureau is provided for, by law, at the provincial capital, the provincial board shall assign a room, or rooms, adequate for installation of the meteorological instruments and office aquipment of the station, and to afford sleeping accommodations for the observers. The room, or rooms, shall be in the provincial building, if practicable, but if there is no suitable room available in the provincial building, then the board shall provide such a room, or rooms, by rental or by construction, and the expense incurred by reason of such rental or construction shall be a charge upon the funds of the province.

SEC. 2. In each municipality, not a provincial capital, where a first or second-class station of the Philippine Weather Bureau is provided for by law, the municipal council shall provide a room, or rooms, adequate for the installation of the meteorological instruments and office equipment of the station, and to afford sleeping accommodations for the observers. The room, or rooms, shall be in municipal building, if practicable, and if there is no suitable room available in the municipal building, then the council shall provide such a room, or rooms, by rental or by construction, and the expense incurred by reason of such rental or construction shall be a charge of the municipality.

SEC. 3. The question of the adequacy of rooms furnished by provincial or municipal governments under the provisions of sections one and two of this Act shall be determined, in each instance, by the Director of the Philippine Weather Bureau, subject to an appeal to the Civil Governor, whose decision shall be final.

SEC. 4. The public good requiring the speedy enactment of this bill, the passage of the same is hereby expedited in accordance with section two of "An Act prescribing the order of procedure by the Commission in the enactment of laws," passed September twenty-sixth, nineteen hundred.

SEC. 5. This Act shall take effect on its passage.

Enacted, March 4, 1902.